Railway Mechanical Engineer

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Prepare for Train Control Maintenance

Forty-nine railroads are supposed to have at least one passenger engine division equipped with automatic train control by January 1, 1925. A number of railroads have already installed some form of automatic train control on portions of their lines, but the problem of maintenance from the standpoint of the locomotive department has not had sufficient time to become of immediate importance. Approximately 80 per cent of the complications that comprise this apparatus are on the locomotive. The track installation is comparatively simple. This means that the larger part of the work of maintenance will fall to the mechanical department, which will, of course, be held responsible for its efficient handling. Success in this work will depend to a large extent on the knowledge and understanding that the enginehouse foremen, locomotive inspectors and road foremen have of the automatic train control equipment. Much can be done now to avoid future trouble by a careful study of the apparatus and its proper care and operation by the officers and men who will be directly concerned with its maintenance. Preparatory consideration should be given to the facilities for inspecting and testing the locomotive equipment at terminals. What preparation and study should be made will vary, of course, according to the type of equipment that has been selected. The fact that the character of the equipment is so different from what the mechanical department has been accustomed to handle should make the work of maintenance of unusual interest to many of the officers and men. Advance preparation and instruction in the maintenance of the automatic train control equipment should be started among the shop personnel so as to avoid the usual experimental blunders brought about through lack of knowledge. Such precautionary measures should tend to eliminate difficulties that might otherwise arise when the work of maintenance becomes a real factor.

Building for the Future

The statement has been made by vocational experts that about 75 per cent of the workers in industry are not doing the kind of work for which they are best suited. We know, also, that productive efficiency is seriously affected by the fact that many of the workers have not received adequate training and do not take the same interest in their work that they would if they understood not only how best to do the work, but its relationship to the functioning of the railroad as a whole, and the part which the railroad plays in the public interest. One development of the year which is now coming to a close has been the greater interest that has been shown in apprentice training on the railroads; there seems, also, to be a larger degree of interest being shown in the more careful selection of employees. A meeting in Detroit of employed boys from the railways was attended by 279 young men, representing 48 railway systems, from 33 states and provinces. Much time was spent in conference or discussion groups. It was clearly evident that these young men were seriously concerned as to how to make the best use of their peculiar talents. Undoubtedly they reflect the attitude of a great number of boys and young men engaged in railroad service. Most of the young men at the Detroit conference were from the mechanical department. From facts which were developed in the group discussions and from the searching questions which were asked in personal interviews, it is apparent that these boys will greatly appreciate advice and encouragement on the part of their superiors. Those of us who are older can recall many instances in which we were greatly inspired or greatly encouraged in our work by a little friendly interest on the part of an older, more experienced man. Sometimes, indeed, a little friendly advice or encouragement has been the turning point in our lives. What a wonderful thing it would be for the future of the railways if all those who are in positions of leadership today would make it a point to help the young men in their departments to find themselves and get a larger appreciation of their responsibilities and opportunities.

Why Not Assign Repairs?

In an endeavor to increase the efficiency of running repair work at engine terminals and to reduce the time locomotives must necessarily be held out of service for repairs, a great deal of attention is being directed towards the forms of organization of enginehouse forces, as well as the manner of assigning work. It is not the intention to discuss here the merits or weaknesses of the principle of assigned power as applied to the dispatching of locomotives. The value of the scheme as a whole and its adaptability depends, to a great extent, upon operating conditions. There is one element, however, in connection with assigned power, the merit of which can hardly be disputed, and that is the keen personal interest which each engine crew takes in the maintenance of its own particular locomotive. At some engine terminals, the work has been re-organized to the extent of assigning specialized gangs to the handling of repair work on locomotives as a class, for instance, passenger, Mallet and freight, and this scheme has made possible a material reduction in the man-hours required to repair locomotives, as well as to increase the number of locomotive miles per failure. One comparatively large eastern road has for some time past had in effect, an organization scheme at one of its large terminals which has developed the idea of specialized gangs to a still greater extent. Not only are the repair gangs in the engine house assigned to work on a certain class of locomotives, but to each gang has been assigned a specific list of individual engines. Experience has proved that in the same manner that the assigned road crew has shown an unusual interest in the maintenance of its own particular locomotive, these repair gangs have developed an unusual interest in their part of the maintenance of the individual

locomotives assigned to them. It is a coincidence that on this road the practice of assigning power to the road crews has been in effect for some time and there is gradually being developed a beneficial point of contact between the engineman and the shop man which has resulted in a spirit of co-operation that has been a contributing factor in the reduction of maintenance expenses at that terminal. An inspection of the detention reports for the division on which that terminal is located, brought out the fact that since this idea of assigned repair work has been thoroughly developed, a marked increase in the number of locomotive miles per failure has been realized along with the reduction of maintenance expenses.

Investigating Locomotive Derailments

One of the most irritating things that can happen in the routine of railway operation is a locomotive derailment. Such accidents interfere with the movement of traffic and usually both the mechanical and maintenance of way departments are called on for explanations. These explanations, of course, must be preceded by investigations. The investigation, in many instances, includes a visit to the scene of the derailment by the department heads or their representatives, a minute examination of the track by those representing the mechanical department and a similar examination of the locomotive by the representatives of the maintenance of way department. Such investigations seldom reveal the real cause of the derailment.

Derailments caused by obvious mechanical or track defects are not difficult to explain and rectify, but it is a puzzle to find the reason for a derailment when both the locomotive and track appear to be in good condition. Both the mechanical and maintenance of way officers are often at a loss to know just how to proceed in order to find the actual cause. In such cases a seemingly never-ending controversy is started owing to the lack of sufficient evidence to place the blame on some particular part or condition of locomotive or track.

A discussion of this kind of derailments is published on another page in this issue. In this article, which is the result of an investigation initiated five years ago, is developed a factor which has been called the factor of wheel bearing. It is a comparatively simple matter to calculate this factor for practically any type of rolling equipment. The value of this factor for the various classes of locomotives a road may be operating, is that it gives the mechanical engineer a figure upon which he can determine the relative possibilities of derailment from locomotives of each class. In case a derailment occurs, he has on file information that will help him to determine accurately what was the actual cause and what steps to take in order to prevent its recurrence.

Excellent results toward the prevention of derailments have been obtained on the roads where this system of investigation has been carried out. It has not only tended to eliminate the usual controversies between the mechanical and maintenance of way departments, but it has brought the two together in a co-operative effort to solve derailment problems. Both departments have a definite object to work for; that is, to keep the factor of wheel bearing within a certain limit. The mechanical department is limited to the extent it can adjust the weights on the drivers in order to get a suitable factor. From the results obtained by the mechanical department, the track department is able to determine the correct curve elevation for safe train operation. When both departments have done everything possible to provide safe locomotive and track conditions, they can then present definite figures to the operating department on which it can base its rules and regulations for the operation of trains. The method described in the article, which is largely analytical, is not intended as a means of discovering the cause of a derailment after it has occurred; its primary objective is to offer something definite toward preventing future derailments.

Precision in the Railroad Shop

In spite of the opposition which has been offered to practically every innovation which tended to remove or circumscribe the exercise of personal skill in industry, the trend has been constantly toward more complete control of industrial processes by the elimination of the variable quality of individual skill. This is seen in the use of special tools in repetitive processes by which parts are completed to extremely close tolerances without skilled attendance, in the control of heating operations by the use of pyrometers and automatic heat regulation, etc. In the railroad shop the freedom from the necessity of close limits in fits has left the control of tolerances generally in the hands of the workmen, on whose skill in estimating allowances the quality of the work depends. During recent months a series of articles in the *Railway Mechanical Engineer* has been devoted to the possibilities of closer tolerances in railroad work, controlled by the use of precision instruments in taking measurements. Among the advantages claimed in these articles may be particularly mentioned the more general interchangeability of many small motion parts and the better systemization of the transfer of measurements to the machine in finishing parts which work together. Probably one of the first objections to the adoption of such practices will be based on the lack of necessity for close tolerances because of the comparatively loose fits required on the locomotive.

No doubt the looseness of locomotive fits permits of considerable variation in the precision of dimensions and, if close precision were costly, it would obviously be undesirable. As pointed out in these articles, however, this has not been found to be the case where precision methods have been applied in a railroad shop. The experience in other industries also supports this conclusion. During the European war considerable difficulty was encountered at the outset in meeting what was considered extreme refinements in tolerances in the production of war material. On a certain shell contract, however, the expedient was adopted of fixing tolerances in the shop with even greater precision than those required to meet government specifications. The result was immediate and salutary. Rejections became negligible and the technique of working to the closer limits was found to be no more difficult and, in fact, to become more a routine matter than had been the case prior to the definite adoption of the closer limits in the shop. This is suggestive of what to a lesser degree may be accomplished in the railroad shop if advantage is taken of the full possibilities of the use of precision instruments. From their use, reduced to a simple routine, good results are less difficult to obtain than from dependence on the judgment of the individual in working out each fit in his own less systematic way.

Co-operative Mechanical Engineering Training

The mechanical departments of the railroads have frequently been criticized for not making more extensive use of men who have received a college training in mechanical engineering. It is true that some few railroads have conducted what is known as special apprentice courses for college graduates. Some of these courses, however, offer little more than the usual shop apprentice training. Others are designed to give the young men a more or less general training in mechanical department methods and practices; in addition to a certain amount of shop training in various departments, they are scheduled to do some work in the drafting room, in the office, in the

enginehouses, on testing of materials and other special work.

The Central of Georgia, in co-operation with the Georgia School of Technology, is developing a scheme of co-operative mechanical engineering education, which seems to possess many advantages over the special apprentice courses in recruiting young college men for railroad work. Boys who can qualify for the entrance requirements of the college and are satisfactory to the railroad on the basis of the tests passed by new employees, are entered in the co-operative courses, which cover a period of five years. In general, the boys spend one month at the college and one month with the railroad. Each boy has an alternate, who is in the shop while he is in the school, or vice versa. They are allowed short vacations during the Christmas holidays and the summer months, these vacations, however, being taken from the time in college and in no way interfering with the maintenance of a uniform force in the railroad service.

There appear to be very distinct advantages in these co-operative courses. In the first place, the boy enters railroad service at about the same age as the regular apprentice and does not have to start at the very beginning after he has finished his college training, as is true in the case of the special apprentice. He thus not only finds it easier to accommodate himself to the work in the railroad shops, but if it appears that he is not suited for this particular class of work, he can arrange for a transfer to something for which he is better suited. Too many boys who graduate from college find out too late that they have made a mistake and that their peculiar talents could be better utilized in other fields than that for which they have prepared. The fact that the co-operative students are earning money one-half of the time they are in college makes it possible for many young men to secure a college training, who for financial reasons would otherwise probably be deprived of that opportunity.

In general, it has been found that the co-operative students take their work more seriously than do the young men in the standard engineering courses. This is to be expected, since they can better understand how the theory which they are receiving in their college training can be applied in a practical way in industry. The Central of Georgia now has 56 co-operative students in the mechanical department, 16 in the electrical department and two in the signal department. Twenty-eight of these boys are first year men, 34 second year or sophomores, 8 third year or pre-juniors, and 4 fourth year or juniors. It is, of course, too soon to predict the final outcome of this experiment, but it would seem to contain great possibilities for providing a splendid training for recruits to the mechanical department.

New Books

Painting of Railway Equipment. *By B. E. Miller, master painter, Delaware, Lackawanna & Western.* 154 *pages, illustrated. 4½ In. by 7½ In. Price* $1.50. *Published by the Simmons-Boardman Publishing Company, 30 Church street, New York.*

A practical book on railway painting has been in demand for some time among railway men. There have been numerous books published on painting but none of them has attempted to specialize on the methods used in painting cars and locomotives. The purpose of this book is to supply such information to the railway painter.

The book is divided into three parts. Part I supplies the fundamental knowledge of paints and tools. The section is introduced with some general remarks on painting which are elemental in nature, but are essential for every painter to know. This is followed by a description of the various pigments and oils used in mixing and obtaining the various colors for different kinds of work. The nature and kinds of varnishes are clearly set forth. This section is concluded with a description of the various tools and how they are used by the painter. Part II covers the painting of passenger car exteriors. A complete description is given of the various processes used for painting the exterior of new wooden and steel passenger cars. This section is concluded with the reasons why passenger cars have to be shopped for repainting and the method of doing this work. Part III gives detailed information covering the painting of passenger car interiors, freight cars and locomotives. Throughout this section will be found special information of value to the railway painter such as methods of refinishing the interiors of new and shopped steel and wooden passenger cars; varnish room work, including a description of equipment such as sash and door racks; the use of an air brush or sprayer for painting freight cars; and the painting of locomotive parts requiring special attention.

Transactions Index, Volumes 1 to 45, 1880-1923. *222 pages, 5½ In. by 8¾ In., bound in half-morocco. Price* $3.00. *Published by the American Society of Mechanical Engineers, New York.*

This edition of the Index to Transactions is the fifth which has been published since the appearance, in 1880, of the first volume of the published literature of the Society.

In preparing the present index, the intention has been to cover as thoroughly as practicable the material hidden sometimes in irrelevant discussions and sometimes in the papers themselves, which, on account of its different subject-matter, would escape the attention of the searchers in an index devoted primarily to the major subjects of formal papers. The items have also been fully cross-referenced.

Inasmuch as the material in the first 25 volumes is quite completely indexed in Volume 27, the present index should apply more particularly to Volumes 26 to 45, inclusive. It will be found, therefore, that the present index contains only a sufficient number of references to the first 25 volumes to locate the papers and their authors. No references to the discussers of these early papers are given, although such references are included in the general index of Volume 27.

Another difference in the present index lies in its arrangement. The general style of The Engineering Index has been followed, grouping alphabetically all items under authors' names and subjects, except memorial notices of deceased members, in the main section. No separate listing of authors or of papers in chronological order is attempted. References to purely Society affairs, such as accounts of meetings and addresses which do not deal with technical subjects, have been omitted. A separate index to memorial notices has been included.

What Our Readers Think

Setting Locomotives to Music

New York.

To the Editor:

At first thought, it seems to require a rather elastic imagination to compare the music of a symphony orchestra to the sounds produced by a locomotive under way—most locomotives, at least. Yet there is in reality a bond of sympathy existing between the endeavors of those who guide the movements of each—that striving for a degree of mechanical perfection that will produce results embodying both harmony and rhythm.

Two well known symphony orchestras have recently presented for the approval of their audiences in this country, a composition by Arthur Honegger, a French composer, entitled "Pacific 231." It seems that this young composer, from childhood, has had a passion for locomotives and if

the favorable comment which his musical production has created may be taken as an indication, it is safe to say that he has been unusually successful in translating the audible impressions of a powerful modern locomotive at high speed into a pleasing musical theme. The composer of "Pacific 231" has drawn a musical picture of a train driving through darkness at high speed. Quoting the words of the musical critic, he has projected an idealized vision of a marvelous modern world in which man has extended himself and his powers through muscles of steel and tissues of copper and brass. He has pictured man as a conqueror of time and space by his mechanical mastery of stupendous forces and the genius with which he has bent them to his will.

All this the composer has accomplished with music. The locomotive engineman may also be credited with a subconscious effort to produce "mechanical music" with the powerful machine under his control when, at the end of each run, he writes on his work report, "Square up valves."

LOCOMOTIVE "TUNER."

Reclaiming Files

LITTLE ROCK, Ark.

TO THE EDITOR:

A question was asked by James Sheridan in the November issue of the *Railway Mechanical Engineer* relative to the use of an acid solution for the reclamation of worn files. Dull or worn files can be sharpened by placing them over night in a solution of one part sulphuric acid to two parts of water. After being removed from the acid solution, they should be rinsed well in clear water.

The acid should be kept in an earthenware vessel.

J. W. BRODERICH,
Gang Foreman, Missouri Pacific.

Speculations on Locomotive Efficiency

COUNCIL BLUFFS, Iowa.

TO THE EDITOR:

The locomotive boiler is a most admirably effective steam producer, notwithstanding the limitations put on its design by considerations of clearance. It has a marked advantage over the stationary boiler, in that the water content is in a state of continual agitation when the locomotive is moving, which augments and assists the natural or gravity circulation of the water in the formation of steam.

To produce steam in large quantities necessitates the consumption of fuel at a rapid rate. On the limited grate area of the coal fired locomotive boiler, as compared with stationary boilers of equal capacity, a thick fuel bed must be maintained. Fresh fuel must be added at the top of the fire. The air for combustion is necessarily admitted at the bottom. Naturally the oxygen of the incoming air first comes into contact with the bottom layers of fuel, with the consequence that most perfect combustion is secured at some point well down in the depth of the fire. Above that point combustion proceeds in an atmosphere more or less impoverished of oxygen and at the upper surface of the fire, where the fresh fuel is undergoing the process of distillation, the oxygen content of the air is at a minimum. The volatile constituents of the fuel, containing hydrogen, require proportionately more oxygen for their perfect combustion than does the fixed carbon, while they actually are supplied with much less.

This condition seems to require two things for its correction. The first is the admission of more air through the grate space, which may be accomplished by careful design. The second is the admission of air above the fire. This latter remedy, to be effective, requires that the air be preheated. It may be accomplished by utilizing the brick arch, with which every locomotive should be provided. The arch tile may be made hollow so that when put in place the hollow spaces connect up to form a passageway for the flow of the air, outlets being provided on the under surface of the tile and the passageway for air connecting up at the lower end of the arch with a hollow stay in the throat water leg. Dampers may be placed over these stays so that control of the air is provided for.

The most nearly perfect combustion attainable requires about 16 lb. of air per lb. of combustible. On our larger locomotives this demands an air supply of one ton or more per minute, or over 25,000 cu. ft.

Locomotive flue gas analyses seldom show an excess of air. Generally the contrary is apparent as indicated by the presence of excessive CO in the flue gases. The problem of draft is therefore intimately related to that of combustion. It is well known that the present method of producing draft is inefficient, but is retained on account of its simplicity and because it does the work required of it, even though wasteful. The inefficiency can be laid to just one thing—excessively high exit velocity of the gases passing out of the stack. The velocity is sufficient to carry the gases up a considerable distance when less would just as well suffice.

In a centrifugal blower fan operating with free inlet and discharging directly into the open air, the power required to drive it is proportional to the cube of the speed. If you double the speed of the fan, it will deliver two times the volume of air at four times the dynamic pressure, thus requiring eight times as much power to drive the fan. The same rule holds good when the propelling power is a jet of steam. The loss is in the excess dynamic pressure of the ejected gases or air. Any experimental work looking to the substitution of a fan or blower to produce draft for the locomotive is sure to run afoul of this fact.

Reduction of exit velocity will necessitate a larger stack. A larger stack will require modification of the exhaust jets by breaking the single jet up into several smaller and more effective jets having larger entraining surface area. Greater continuity of the flow of the exhaust through the jets must be secured.

This latter suggestion leads to certain inferences. Just why is it necessary to provide four separate and independent exhaust passages up to the base of the nozzle? Why not simplify cylinder and saddle construction by leaving them out altogether, thus reducing pattern and molding costs and permitting the use of cast steel in saddle construction with increased strength and reduced weight?

What will happen if the separate exhaust passages are omitted and the space within the saddle be made into a receiver with the exhaust nozzle applied in the usual manner? Conceivably, on starting the locomotive, the first few exhausts will be irregular, but on the attainment of any speed this will disappear and the pressure within the receiver will become reasonably constant. The flow of the exhaust through the nozzle will then become practically continuous, a condition much more to be preferred for the production of draft than the intermittent action now secured.

The suggested omission of the exhaust passages leads also to further speculation. The receiver space may be utilized for the installation of a feed water heater, preferably of the closed type, an ideal location for it, as its heating surface will be in contact with the entire volume of exhaust steam, without in any way offering obstruction to its flow to the nozzle and with the assurance that maximum feed water temperatures will be secured.

The saddle may be made of cast steel in a single unit casting with independent unit cylinders bolted on, making the replacement of a damaged cylinder a simple matter and permitting the use of such material for cylinder construction as may be best suited with the assurance of better castings. Both unit cylinders may be cast from a single pattern with considerable saving in pattern cost. Several hundred pounds of excess weight may be eliminated.

THOMAS E. STUART.

Derailments of Locomotives on Curves

An Investigation of the Mechanics of Curving To Determine Why the Wheels Leave the Rail

Part I

By Roy C. Beaver* and Marion B. Richardson†

THOSE who are called upon to investigate the causes of locomotive derailments are frequently puzzled to know what to say in their reports. An investigation of the locomotive does not disclose any mechanical defect and the track seems to be in perfect condition. The operating conditions at the time of the derailment were satisfactory, and still the locomotive left the track. In many cases there does not seem to be any one factor or combination of factors at which to point the finger of blame.

One of the most common derailments on a curve is that in which the outside leading driver climbs the rail while the locomotive is moving at slow speed. Such derailments usually occur with some one class of locomotives, under certain definite conditions as to degree of curvature and track elevation, and operating conditions peculiar to the locality. Occasionally the second driver will also figure in a derailment. Such derailments, while causing very little property damage, are costly and exasperating. They tie up the line, cause delays and annoyance and frequently require the use of the wrecking outfit because of the heavy locomotives which are usually involved. This discussion, which is based on a study and investigation of a number of such derailments, is made in an attempt to show what might be the causes of such derailments, and where to look for the trouble when these derailments take place.

It is practically impossible to arrive at exact values for the forces and stresses that occur in the locomotive and track, by a method of analysis. This is owing to the varying conditions found and the assumptions which must necessarily be made. Yet this is the only method that the majority of engineers have for arriving at conclusions in regard to such derailments. There are instruments for determining the thrusts exerted by locomotive drivers on the rail, but these instruments are costly. Their use requires a great deal of preparation and time and they require considerable care in handling, as well as in the interpretation of results. Such apparatus is not available to the average mechanical officer for his investigations. Therefore, it is necessary to study the case analytically with the hope of shedding some light on the problem to the end that faulty conditions will be corrected and future derailments prevented.

THIS article is the result of a series of investigations begun by Mr. Beaver, assisted by Mr. Richardson, in the spring of 1919. The original investigation resulted in the determination of a factor which was called the factor of wheel bearing. This factor is the ratio of the weight on the wheel to the vertical thrust which tends to lift the wheel from the rail. When this factor is equal to, or greater than one, the wheel will stay on the rail and when it is less than one, the wheel will climb the rail. The results of the original investigation were incorporated in a thesis, which is now the property of the School of Engineering of The Pennsylvania State College, to which reference has been made in preparing this article. At that time the center of rotation, in the case of a Santa Fe type locomotive, was considered to be at the point of contact of the inside main driver with the rail. Subsequent investigation has shown that the center of rotation varies with different conditions of equipment and track.

The locomotives involved in the derailments which led up to this discussion were of the heavy Mikado and Santa Fe types. The speeds were slow, not over 10 miles per hour, and it was usually the outside leading driver which was derailed. Sometimes it was both the leading and second drivers that climbed the rail. There were instances where the locomotive had traveled considerable distances before the engineman was aware that a derailment had taken place. These derailments took place on curvatures of from about 4 deg. to 12 deg.

In order to simplify this discussion, the writers have chosen to include only the Santa Fe type of locomotive. The principles involved, however, apply equally well to any other type of locomotive. Furthermore, as these derailments took place at low speeds, the conditions were considered to be static rather than dynamic and centrifugal force would therefore have little effect and was not taken into account in this study.

This discussion is intended to be qualitative, rather than quantitative. It is desired to point out the principles rather than to give definite figures for any particular locomotive and for this reason the figures used in this article and the selection of the Santa Fe type are solely for the purpose of illustrating and giving a definite form to these principles.

How a Locomotive Traverses a Curve

Apparently a locomotive rolls around a curve with little effort, but when curve friction is taken into account, train resistance formulas show that the work to be done in curving is a factor to be reckoned with. Suppose a locomotive going east passes around a curve after which it is traveling north. During the time the locomotive has gone around the curve it has rotated about some point in its wheel base through an angle of 90 deg. That is, while it was rolling ahead, it was also slipping sidewise; the treads of the wheels slipping laterally on the tops of the rails. It is evident that there must also have been a longitudinal slipping of some of the wheels, because the distance around the curve on the outer rail is longer

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†Associate editor, *Railway Mechanical Engineer*.

than the distance on the inner rail. These lateral and longitudinal slippages, or their components, must be overcome to get the locomotive around the curve and the work must be done by the flanges. At high speeds, centrifugal force must also be overcome, but its effect is very small at slow speeds. In order to fix these ideas clearly in mind, consider a locomotive without flanges to be traversing a curve on a plane surface without rails, as shown in Fig. 1. The traction of the locomotive if not guided would cause it to move in the direction of the arrow *X*. But it is desired to make it move in the curved path *AB*. In order to do this it is necessary that pulling forces be applied at the front and back, as at *Y* and *Z*, or pushing forces, as at *Y'* and *Z'* or combinations of these forces, at the same time that the tractive force is acting. By regulating the amounts of the forces *Y*, *Y'*, *Z* and *Z'* in conjunction with the tractive force, the locomotive will follow the curved line *AB* without the use of rails and flanges. Instead of the large forces *Y*, *Y'*, *Z* and *Z'*, we could employ a larger number of smaller forces as *a*, *b*, *c*, *d*, *e* and *f*. It will be observed that the forces *Y* and *Z*, or the larger number of smaller forces, cause the whole locomotive to rotate about some point in its wheel base and that the location of the point of rotation can be varied by altering these forces.

Now consider that this locomotive, still without flanges, is placed on the track. If the rotating forces are just right, the locomotive will go around the curve safely. The action of the pairs of wheels will be the same as large cylinders which tend to roll at right angles to their axes, as indicated by the arrows in Fig. 2. Thus first, second and third pairs of drivers tend to roll off on a tangent to the curve and leave the rail on the outside of the track and the fourth and fifth pairs of drivers tend to roll over the rail on the inside of the track. So if the guiding forces are removed, or are too small for the work to be done, the locomotive will assume the position shown in Fig. 3.

Position of a Locomotive on a Curve

With these ideas in mind, consider Fig. 4 which shows the position of the drivers of a Santa Fe locomotive on a curve. The solid lines are the position of the locomotive at any instant and the dotted lines at any succeeding instant. The curvature of the track shown in the drawing is exaggerated for clearness.

The locomotive is moving in the direction of the large arrow. The axles are held parallel to each other by the frame and with the possible exception of the main axle, make angles with the radii of the curve, as shown at *A* and *B*. The angularities between the axles and the radii cause similar angularities between the flanges and rails, which are commonly termed the striking angles. Thus the wheels roll, with respect to the rails, as shown by the small arrows on each wheel. This shows how the outside number one and two drivers tend to climb over the outer rail and the inside number four and five drivers tend to climb over the inner rail. Furthermore, the striking angles cause the points of contact between the wheels and rail to move ahead of the centers of the outside number one and two and inside number four and five drivers, and back of the centers of the opposite wheels. The locations of the points of contact are on the lines *C*. The distances from the centers of the wheels to the lines *C* depend upon the curvature, the length of wheel base and the position of the wheels in the wheel base.

Whether or not there is actually contact between the wheel and rail on the lines *C* depends upon the curvature of the track and the lateral play between the backs of the drivers and the journal boxes. Any curvature will cause the number one wheel to roll against the outer rail and cause contact at *D* and any curvature would cause the number two wheel to roll against the rail at *E*, if the frame of the locomotive did not exert a force to hold it away. It has been found that

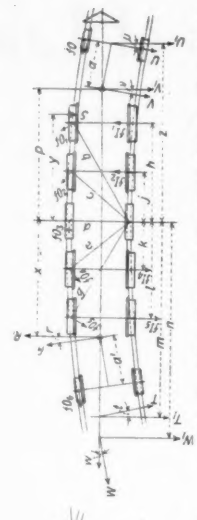


Fig. 5—The Forces and Reactions of a Locomotive When Curving

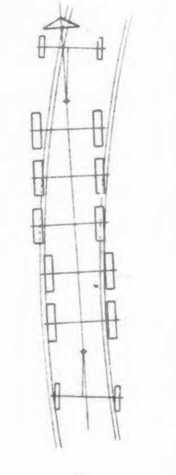


Fig. 3—Position a Locomotive Tends to Assume When the Guiding Forces Are Removed

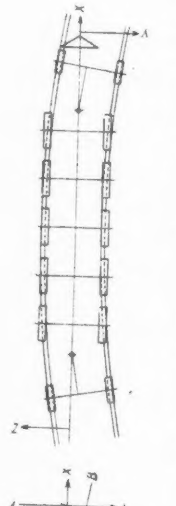


Fig. 2—A Locomotive Without Flanges on a Track

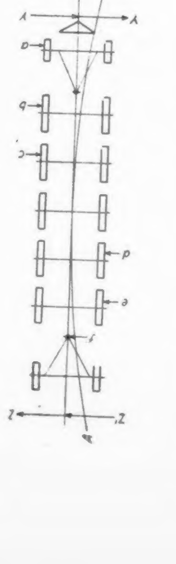


Fig. 1—A Locomotive Without Flanges on a Plane Surface Without Rails

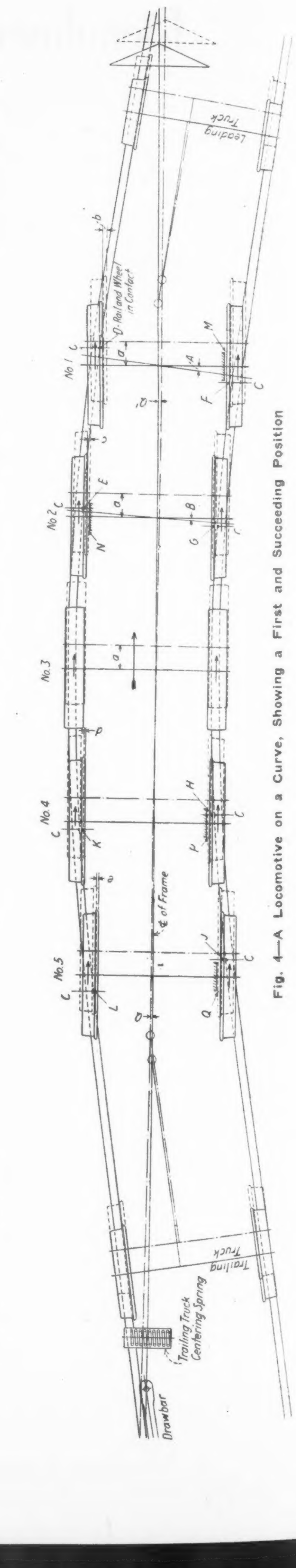


Fig. 4—A Locomotive on a Curve, Showing a First and Succeeding Position

a locomotive just out of the shop, with the lateral taken up, will have contact between the flange of the second driver and the rail at E up to about four degrees of track curvature, after which there is clearance at E. This explains why derailments do not take place so commonly under four degrees, for below that curvature, there are two driving wheel flanges doing the work of guiding instead of one. But when the departure of curvature becomes too great for the driving box lateral, as it does from about four degrees upward, the flange is pulled away from the rail at E, the assistance that the number two flange has been giving is withdrawn and the number one flange must take on the extra load. Naturally, there is clearance at the opposite points shown at F and G, for these drivers tend to roll away from the inside rail. In spite of the fact that the inside number four and five drivers tend to roll over the inside rail toward the inside, an observation of locomotives on curves shows there is clearance at H and J, as well as at K and L. We naturally expect a

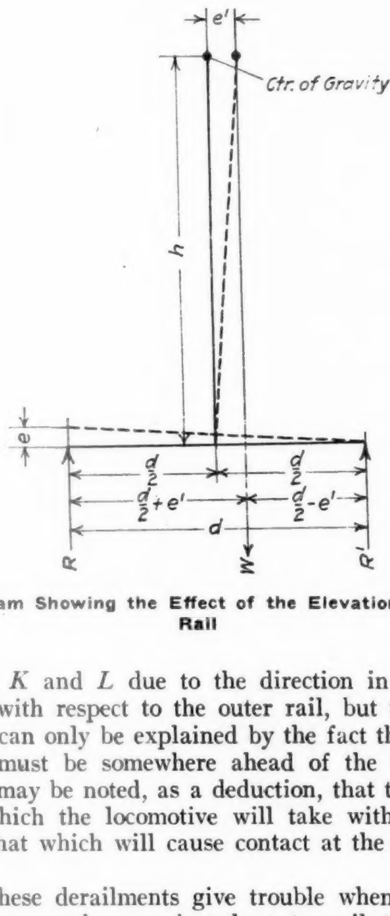


Fig. 6—Diagram Showing the Effect of the Elevation of the Outer Rail

clearance at K and L due to the direction in which these wheels roll with respect to the outer rail, but the clearance at H and J can only be explained by the fact that the center of rotation must be somewhere ahead of the number four drivers. It may be noted, as a deduction, that the maximum curvature which the locomotive will take without complete binding is that which will cause contact at the points D, L, G and H.

Because these derailments give trouble when the number two flange does not bear against the outer rail, this study has been limited to that condition. The outside number one hub bears against the frame, putting all the lateral in the number one pair of drivers at M, while the frame rotates in the direction of the curve. This rotation of the frame causes it to bear against the inside number two and outside number four and five hubs, which places the lateral in those drivers at N, P and Q, respectively.

Succeeding Positions of a Locomotive on a Curve

Consider the locomotive in Fig. 4 to have moved the distance a to the position shown by the dotted lines. After the locomotive has fully entered the curve, other conditions being equal, the contacts and clearances at the hubs, will remain constant until the locomotive starts to leave the curve. It will be observed that while the locomotive has moved ahead the distance a, the number one drivers have moved to the right the distance b; the number two drivers have moved to the right the distance c; the number four drivers have moved to the left the distance d, and the number five drivers have moved to the left the distance e. Thus it will be observed that a locomotive does not simply roll around a curve, but that it both rolls and slides around the curve with a sidewise slipping of the wheels, and that for each longitudinal advance there is a corresponding lateral slipping. This is nothing more nor less than a lateral rotation of the locomotive, the rolling of the wheels and longitudinal advance having little to do with it, except to make the necessary rotation. This rotation is shown by the positions of the center lines of the locomotive in Fig. 4, the center of the locomotive having been rotated through the angle Q'.

The Center of Rotation

The center of rotation varies for different types of locomotives, curvatures of track, speeds and locomotive and track conditions. It will vary even for any given locomotive and curvature with the slightest amount of variation of speed, track elevation, surface and alinement, as the throttle is opened or closed, or as the brakes are applied or released. However, for the conditions selected, it may be definitely located on the inner rail, approximately under the main driving wheel. Owing to the elevation of the outer rail and low speed with the absence of centrifugal force, the most slipping will occur under the outer drivers and not the inner, as the outer drivers carry less load than the inner for these conditions. Therefore rotation takes place about some point on the inner wheel base. Furthermore, if the point of rotation is at or back of the contact point of the number four driver, the clearance at H would become zero, as this wheel rolls in the direction of the arrow, which it does not do in practice. Therefore the point of rotation is somewhere ahead of the number four driver, and it will have to be an appreciable distance ahead of this driver to maintain the clearance at H. Finally, if the point of rotation is appreciably ahead of the main driver, the distance from the center of rotation to the contact point of the number one driver at D would be less than the distance from the center of rotation to the contact point of the number five driver at L, so that a given lateral movement at D would produce a greater lateral movement at L taking up the clearance at L, which again is not borne out in practice. Therefore the center of rotation must be near the inside main driver. A small variation in the location of this point will not affect the principles involved nor materially affect the numerical calculations. Thus for the sake of simplifying both the analysis and computations, this point will be considered as being at the center of the tread of the inside main driver.

Forces to Be Overcome in Rotating

We have seen that the rotating forces must overcome the lateral slipping of all the driving wheels, or the diagonal components thereof, except that of the inside main driver, about which the rotation of the locomotive takes place. There is also a longitudinal slipping of the outer wheels, due to the fact that the distance around the curve on the outer rail is longer than the inner and that the outer wheels carry a lighter load. This longitudinal slipping, or its diagonal component, must be overcome as well. The trailing truck, or the leading truck, when the locomotive is backing, also exerts a force opposite to the direction of curving, and this too, must be overcome. Finally, the pull of the drawbar has a component which adds its share to the already heavy burden of the rotating forces. In all of this it must be kept in mind that centrifugal force is not considered to be a factor at these low speeds. Each of the forces to be overcome may be analyzed and evaluated.

These forces can be more clearly understood by referring to Fig. 5. If O_1 is the weight on the outside number one driver, O_2 the weight on the outside number two driver, I_1

the weight on the inside number one driver, etc., and f the coefficient of friction between the wheel and rail, then the forces $f\,O_1$, $f\,O_2$, $f\,I_1$, etc., are the forces required to cause sliding of the wheels, longitudinally in the case of the outside main driver, laterally in the cases of the inside number one, two, four and five drivers and both longitudinally and laterally, or diagonally, in the cases of the outside number one, two, four and five drivers.

Driving Wheel Friction

In arriving at the loads on the drivers, we must bear in mind that the elevation of the outer rail causes the center of gravity of the locomotive to the thrown toward the inside of the curve, thus taking weight off the outside wheels and putting additional weight on the inside wheels. This can be understood from Fig. 6, in which the solid lines show the locomotive when horizontal and the dotted lines show the locomotive when on a curve with the elevation e. Suppose h to be the height of the center of gravity above the top of the rail and d the distance from center to center of the tops of the rails. Then $é$, the distance the center of gravity will move toward the inside of the curve, is $\frac{eh}{d}$. Also the reactions R and R' due to the load W being off center will be

$$R = \frac{w\left(\frac{d}{2} - e'\right)}{d} \text{ and } R' = \frac{w\left(\frac{d}{2} + e'\right)}{d}.$$

These wheel loads are to be used for O and I, respectively.

In selecting a value for the coefficient of friction f, a study of the data and tables given by various authorities, and also of the results of investigations made at The Pennsylvania State College shows that it varies from .10 to .41, and that a fair value for steel tires on steel rails would be about .20. In selecting this figure, it was borne in mind that the coefficient of friction would be less for a revolving wheel than for a stationary wheel, as shown by the fact that a plug gage can be slipped more easily into a ring gage if it is revolved at the same time it is pushed in. It may also be noted here that the coefficient of friction of rest is greater than that of motion, and that this coefficient decreases in value as the speed increases. We would, therefore, naturally expect derailments to occur on curves of moderate curvature, say up to about 12 degs. The speed of lateral slipping, for any given locomotive speed, increases with the curvature, and therefore the coefficient of friction of lateral slipping for the higher curvatures, being less, does not cause such a high side thrust of the outer wheel.

Trailing Truck Action

Trailing trucks are of various types, but suppose we have one of the sliding type with a centering spring. This spring is compressed on a curve, and exerts a pressure on the locomotive frame toward the inside of the curve. From the known dimensions of the spring we have the diameter of the steel d, the mean radius of the coil r and the number of coils n. Also from the conditions of the curvature, we know the deflection F. Then from the formula $T = \frac{FGd^4}{64\,nr^3}$ we are able to calculate the force T, which is exerted by the spring, taken the modulus of torsional elasticity, G, at 12,500,000. This force is not at right angles to the frame but is transmitted to the frame through the usual ball and socket connection. Therefore we must consider the component normal to the frame, which is $T_1 = T \cos t$. Trailing trucks of the rocking or other types would be considered in a similar manner, except that in these types the load is applied on the center of the truck, whereas when centering springs are employed, the load is applied at a considerable distance back of the truck center.

Effect of the Drawbar Pull

When the locomotive is pulling a train or even the tender, there is a side thrust to be considered, the intensity of which will depend upon the curvature and the actual drawbar pull. We shall include this factor in the study and set for it a figure based on a nominal drawbar pull of 30,000 lb. In making investigations this factor will have to be studied carefully in order to be evaluated properly. Referring to Fig. 5, the side thrust of the drawbar pull is $W_1 = W \tan w$.

Moments of Forces to Be Overcome

Thus we must overcome the forces fO_1, etc., fI_1, etc., T_1 and W_1, the intensities of which have just been analyzed.

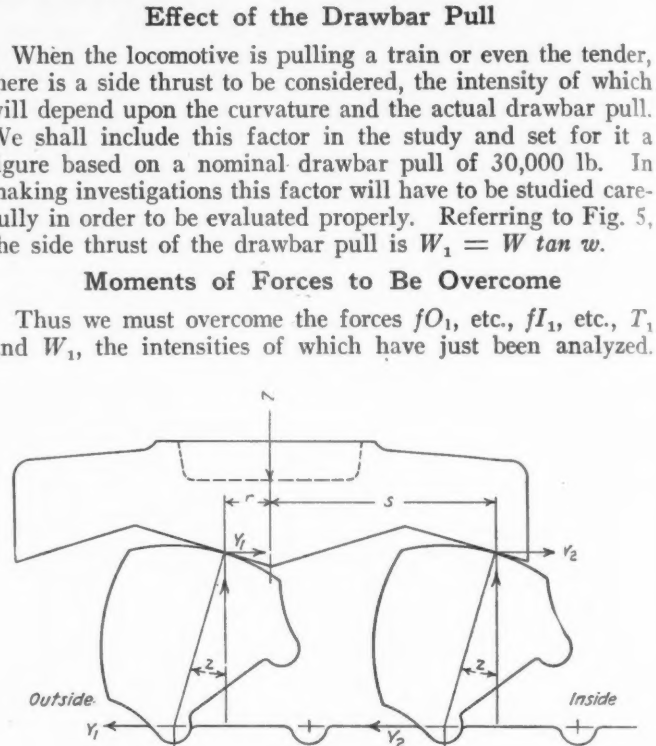


Fig. 7—Reactions in the Leading Truck

Since we have considered rotation to take place about the inside main driver, the moment arms of these forces are b, c, d, etc., as given in Fig. 5. Summing up these factors, in order to cause the locomotive to rotate about the inside driver, we must exert sufficient turning moment to overcome these resisting moments which are

$$bfO_1 + cfO_2 + dfO_3 + efO_4 + gfO_5 + hfI_1 + jfI_2 + kfI_4 + lfI_5 + mT_1 + nW_1$$

Overcoming the Reactions

Opposed to the above forces are reactions which must cause sufficient turning moments to balance those of the resisting forces if a derailment is not to occur. First of all, we have the guiding reaction of the leading truck wheel flange and then the reaction of the leading driving wheel flange. Owing to the conditions already assumed, there are no other flange reactions. Assisting the two flange reactions are the lateral components of the side thrusts of the leading truck radius bar pin and of the trailing truck radius bar pin. Truly the reactions are few compared to the resisting forces and consequently they must be high in numerical value to meet the work they are called upon to do. Referring again to Fig. 5, the leading truck reaction is U with its lateral component U_1; the leading driving wheel reaction is S; that of the leading truck radius bar center pin is V, with its lateral component V_1, and that of the trailing truck radius bar pin is R, with its lateral component R_1.

An Analysis of the Reactions

As in the case of the trailing truck, there are also various kinds of leading trucks; and for purpose of analysis one of the constant resistance, rocker type has been selected. Referring to Fig. 7, let the load on the truck be Z. This load will then have the vertical reactions at the rockers of $Z_1 = \frac{Zs}{r+s}$ and $Z_2 = \frac{Zr}{r+s}$, respectively. The horizontal components of the reactions are $Y_1 = Z_1 \tan z$ and $Y_2 = Z_2$

tan z respectively, which, added together, equal U in Fig. 5. U has its lateral component which is $U_1 = U \cos u$. The reaction of the leading truck radius bar pin causes the wheels to follow the curve radially. In order to do this the reaction of the pin must be sufficient to cause the slipping of one of the wheels, at least when the coning is not precisely right, as is generally the case, all because the outer and inner rails of the curve are not the same length. Because the outer wheel carries the lesser weight, it is the one to slip and the force required to slip it is fO. If d is the distance from center to center of the rails, as in Fig. 6, and a the distance from the pivot pin to the center of the truck as in Fig. 5, then by taking moments about the inside wheel, the reaction is $V = \dfrac{fOd}{a}$ and its lateral component is $V_1 = V \cos v$.

The reaction of the trailing truck radius bar pin is due to the same cause as the reaction of the leading truck radius bar pin and may be found in a similar manner. Thus let d again be the distance from the center of rail head and a' the distance from the pivot pin to the center of the truck. Then by taking moments as in the case of the leading truck, the value of the side thrust is $R = \dfrac{dfO_6}{a'}$ and its lateral component is $R_1 = R \cos r$. The reaction of the leading driver will be considered as the unknown and when once determined, it will enable us to tell whether or not that wheel will stay on the rail. Thus by using the moment arms given in Fig. 5, in a manner similar to that used for the resistances, the combined moments of the rotating reactions are $zU_1 + yS + xR_1 + pV_1$, in which S is unknown.

The Vertical Reaction

This horizontal thrust S has a vertical reaction S_1 which is opposed by the weight on the driving wheel. If the weight is not sufficient to overcome the reaction S_1, a derailment will result. The relation of the wheel and rail is shown in Fig. 8, in which the rail is curve-worn, as that is usually the condition in which the rail is found when a derailment takes place. The relation is similar to that of an inclined plane, the thrust S producing the normal reaction s and the vertical reaction S_1. If the angle of incline is i, then $S_1 = S \cot i$. When the wheel is at rest, then the reaction S_1 is the only one which the weight of the wheel must overcome. But when the wheel is rotating, there is an additional vertical reaction to be overcome, which arises out of the friction between the flange and rail due to the normal pressure s. The contact point being at the distance q ahead of the center of the wheel, the friction at this point would cause the wheel to tend to rotate about the bearing point, rising off the tread, so that some of the weight of the wheel is required to hold it down against this friction. This can be better understood by recalling that the wheel bears against the rail at an angle, causing it to nose into the rail and tending to make it roll up the inclined plane and go over the rail. This friction, due to the binding action, high bearing pressure and small area of contact, is very high, and its cofficient, f', may safely be put at .35. The normal force $s = \dfrac{S}{\sin i}$, and the friction is then $f's$. This friction then has the vertical component $s_1 = f's \sin i$. Therefore the vertical reaction which must be overcome by the weight on the wheel while rotating is $S_1 + s_1$.

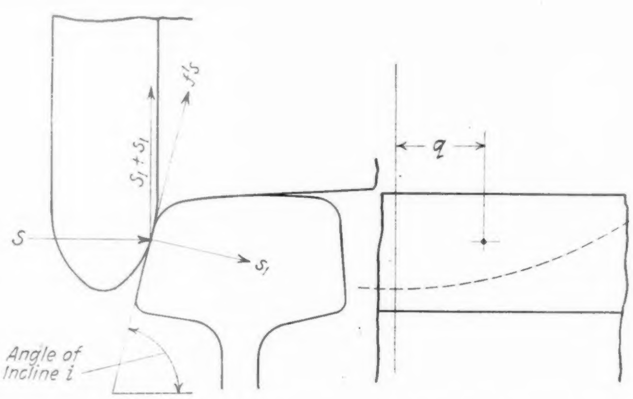


Fig. 8—Relation of the Horizontal to the Vertical Forces at the Wheel

The Factor of Wheel Bearing

The ratio of the weight on the wheel to the vertical thrust which tends to lift the wheel may be called the *factor of wheel bearing*. When this factor is equal to or greater than 1.00, the wheel will stay on the rail and when it is less than 1.00, the wheel will climb the rail. As soon as the flange gets on top of the rail, the factor of wheel bearing increases, but it is too late and the longitudinal rolling carries the wheel over. Sometimes after the leading driver has left the rail, the factor of wheel bearing of the second driver becomes sufficiently low to cause it also to climb over the rail, but such cases, while reported occasionally, are not nearly as common as derailments of the leading driver only. One would naturally suppose that when the first driver left the rail, the additional weight thrown upon the second driver would give it the necessary factor of wheel bearing to keep it on the track, which it does in most cases.

[This discussion will be continued in the January issue, in which a practical application of the factor of wheel bearing will be given.—EDITOR.]

Locomotive Resistance and Tractive Force—A Correction

AN article on Locomotive Resistance and Tractive Force by Kiichi Asakura, mechanical engineer, Japanese Government Railways, Tokio, Japan, was published in the September, 1924, issue of the *Railway Mechanical Engineer*. The following corrections should be made to the formulas on page 524, which read thus:

$$w = 2.2\ 0.015\ v \text{ per metric ton.}$$

and

$$w = 5.\ 0.054 \text{ per long ton.}$$

These should read

$$w = 2.2 + 0.015\ v \text{ per metric ton.}$$

and

$$w = 5 + 0.054\ v \text{ per long ton,}$$

respectively.

The following correction should also be made in the three formulas for boiler efficiency on page 525 where the quantity $\left(\dfrac{G_4}{H}\right)$ is given. This should read $\left(\dfrac{G}{H}\right)^4$. The last formula shown on this page which reads

$$\frac{\text{Cylinder dia. in.} \times \text{stroke, ft. or in.}}{\text{Dia. of driver, ft.}} = \frac{d^2l}{D}$$

should be

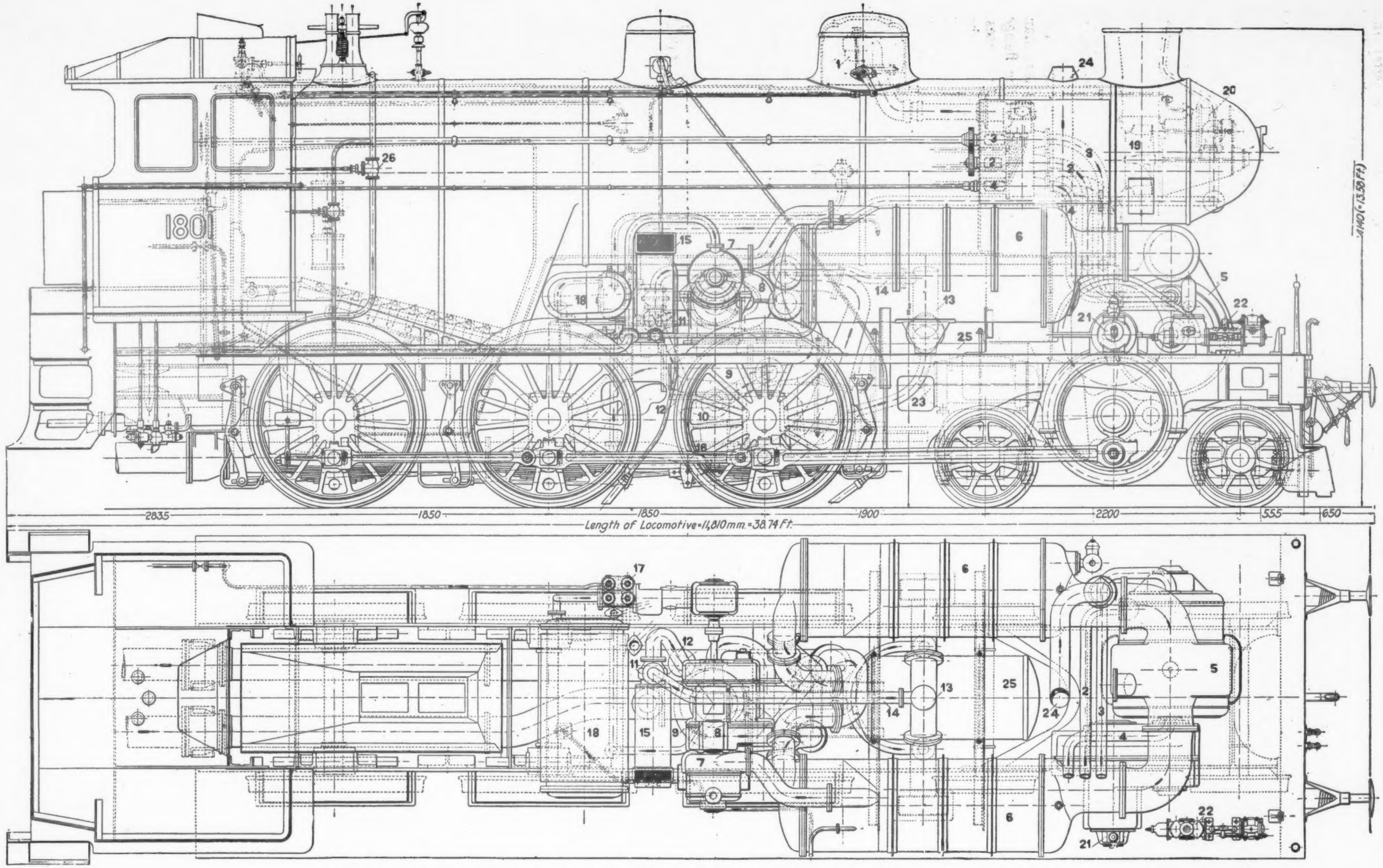
$$\frac{(\text{Cylinder dia. in.})^2 \times \text{stroke, ft.}}{\text{Dia. of driver, ft.}} = \frac{d^2l}{D}$$

and the formula

$$\frac{\text{Grate area sq. ft. or sq. in.}}{\text{Cylinder volume (one cyl. cu. ft. or cu. in.)}}$$

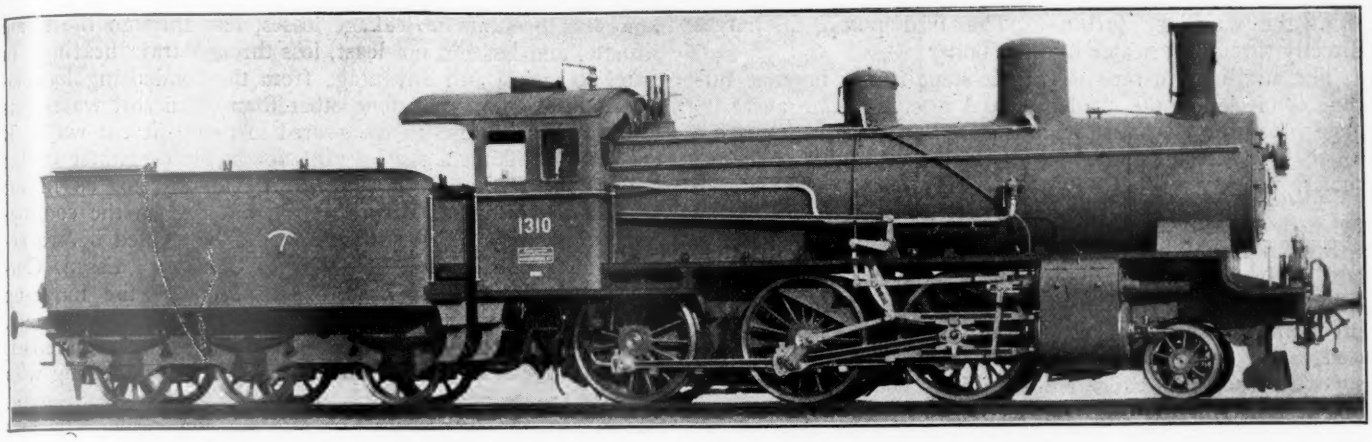
should be

$$\frac{\text{Grate area sq. ft.}}{\text{Cylinder volume (one cyl. cu. ft.)}}$$



Plan and Elevation Drawing of the Zoelly 1000-hp. Turbo-Locomotive (Dimensions Are in Millimeters)

1. Main governor valve.
2. Steam valve for running ahead—normal.
3. Steam valve for running ahead—overload.
4. Steam valve for running astern.
5. Main turbines for running astern and ahead.
6. Condensers.
7. Turbine driving condenser auxiliaries.
8. Reduction gear.
9. Circulating water pump.
10. Centrifugal pump—water for air ejector.
11. Water-jet air ejector.
12. Water delivery pipe from pump 10 to ejector.
13. Air collector for air from condensers.
14. Air suction pipe from collector to ejector.
15. Air separator.
16. Condensate pump.
17. Feed pump.
18. Feedwater heater.
19. Furnace fan.
20. Turbine for driving the furnace fan.
21. Oil pump for main turbines.
22. Stand-by oil pump.
23. Oil cooler.
24. Atmospheric exhaust.
25. Air storage for automatic air brake.
26. Live steam for turbine on recooler.



The Original Locomotive Before Its Conversion to Turbine Drive

Mogul Locomotive Converted to Turbine Drive*

Test Shows Greater Operating Economy and Increased Capacity with the Same Boiler

By H. Zoelly

Chairman, Escher Wyss & Co., Zurich, Switzerland

ESCHER WYSS & CO., Zurich, Switzerland, in conjunction with the Swiss Locomotive Works, Winterthur, has successfully converted a mogul type reciprocating locomotive into a turbine driven condensing locomotive. The principal change, in general appearance, as compared with the original locomotive has been the replacement of the cylinders by a turbine. The original boiler, equipped with a Schmidt superheater, has been provided with a turbine-driven fan arranged in the front part of the smokebox as a substitute for the draft produced by the exhaust steam of the reciprocating engine.

The Main Turbines

The new locomotive was constructed for the same performance as the old one, so that the six-stage impulse Zoelly turbine for running ahead was designed to give 1,000 hp. at the crankpin. The back-up turbine consists of a simple compound wheel and is contained in the same casing as the ahead turbine. The turbine rotor, comprising both the ahead and back-up wheels, is made out of a solid block, the blades being inserted in slots in the wheel rims. The turbine drives through a double-reduction gear (the first reduction 1:7 and the second 1:4.1), a jack-shaft carrying the crank-pins and the drive to the wheels being obtained by connecting rods.

The turbine casing with the reduction gear, intermediate shaft, jackshaft, and all bearings are mounted on a one-piece steel casing which is riveted to the locomotive frames. The turbine is placed in front of the boiler, its axis parallel to the locomotive axles.

Steam admission to the ahead or back-up turbines is controlled by valves which are operated from the enginemen's cab. For running ahead two groups of nozzles have been provided in the first guide wheel, one allowing the passage of about 11,000 lb. of steam when fully open, and the other for 4,400 lb. One or the other of the valves, or both, is fully open, according to the load. Intermediate quantities are obtained by throttling with the main governing valve. Only one valve which allows a total of 15,500 lb. of steam to pass, has been provided for running backwards. Smaller quantities are likewise obtained by throttling down with the main governing valve. The efficiency of the back-up turbine is lower than that of the ahead turbine for a locomotive usually runs ahead. Backing up is only provided for switching maneuvering, or for use in cases of emergency where a smaller amount of power is required.

The maximum traveling speed of the locomotive is 47 miles per hour and is limited by the type of locomotive. The driving wheels have a diameter of 60 in. At 47 m.p.h. the turbine makes 7,500 r.p.m. The turbine speed is of course, proportional to the traveling speed. When running ahead the back-up wheel rotates in a vacuum, as is common practice in marine propulsion. The wheel friction for the simple back-up turbine is small, and the losses are therefore insignificant.

The Condensers and Auxiliaries

The steam passes in about equal quantities from the exhaust end of the turbine, in both the ahead and the back-up turbines, to condensers placed longitudinally on each side of the boiler. These condensers are water cooled and are of the surface type.

All auxiliaries of the condensing plant are driven by one small turbine which revolves at 9,000 r.p.m. This speed is reduced to 1,200 r.p.m. through a reduction and bevel gearing and drives a vertical shaft carrying the circulating-water, air, and condensate pumps. The circulating pump takes water from the tender and forces it through the condensers and back again to the recooler. The air pump discharges at a pressure of about 75 lb. to a water-jet air ejector which communicates with the two condensers. It is designed so that the air in the air separator can escape into the atmosphere and the water return to the suction side of the circulating pump.

The condensate from the condensers is led to the condensate pump, which latter discharges at about atmospheric pressure into the feed pump. The latter is placed on the side platform of the locomotive. It is a reciprocating pump running at 59 r.p.m. and is driven through a second reduction

*Abstract of paper presented before the annual meeting of the Railroad Division of the American Society of Mechanical Engineers. The paper also appeared in the November issue of Mechanical Engineering, published by the society.

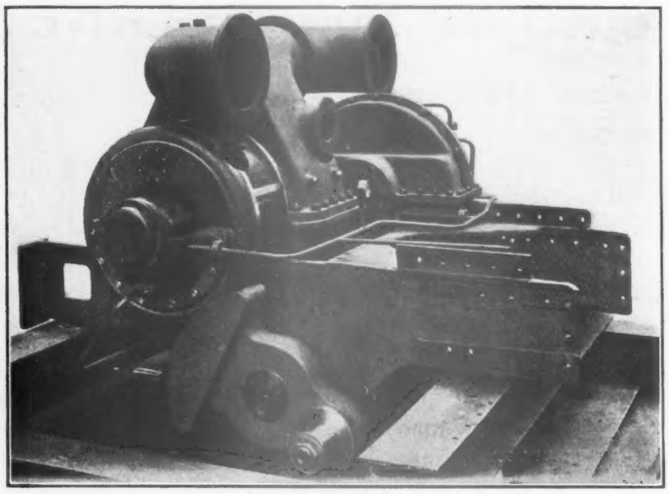
from the auxiliary turbine. The feed pump discharges directly through a heater into the boiler.

The auxiliary turbine is a three-stage Zoelly impulse turbine connected to the condenser and receives steam at 11 lb. gage pressure. Exhaust steam is used in this turbine from a back-pressure turbine which drives the ventilator of the recooler.

The Forced Draft Fan

Special means had to be provided for producing the firebox draft, as the exhaust steam was no longer available. The locomotive was first equipped with a forced draft for producing pressure under the grate. After a long series of tests, however, it was found necessary to change over to the suction principle.

The fan is of the centrifugal type, provided with a spiral casing, and is capable of producing a vacuum in the smokebox of 8.2 in. of water. A maximum of 280 cu. ft. of flue gases can be discharged per second when running at 1,500 r.p.m. The fan is driven by a small turbine through a gear



The Turbine Casing and Balanced Crank

with a transmission ratio of 1 to 6. The turbine receives live steam and exhausts with a back pressure of about 7 lb. gage to the feedwater heater. The admission of steam to the turbine is regulated by a valve which is also operated from the enginemen's cab. The exhaust steam from the turbine which drives the fan is passed into the heater as there is a certain ratio between the quantity of feedwater and the exhaust steam from that turbine. If for some reason there should be no water in the heater and the steam could not condense, a safety valve opens a connection from the heater to the condenser. The condensate of the heater steam always escapes directly to the condenser and thus goes to the boiler along with the condensate of the main circuit.

This design lacks the advantage of the usual draft producer, i.e., the proportioning of the draft to the quantity of steam required in the main turbine. This, however, can be realized on condensing locomotives by bleeding steam from the main turbine.

The design of the Westinghouse air pump does not quite suit the different operating conditions of the turbine locomotive as the exhaust steam is lost and cannot be used on account of the oil it contains. In future designs the natural course will be to employ a rotary pump, which can be driven by the same auxiliary turbine that drives the condensing auxiliaries, thus returning all steam to the boiler.

The Boiler Feedwater

Theoretically the condensing locomotive does not need any additional water for boiler feeding, as the water in the boiler is working on a closed circuit. It is practically impossible, however, to eliminate leakage losses, loss through the steam whistle, and last but not least, loss through train heating. In order to obtain full advantage from the condensing locomotive it is essential that none other than clean soft water gets to the boiler. This can be assured in two different ways. It is possible to have a special tank for boiler feedwater on the tender, the feeding being effected by an injector as in the case of the ordinary locomotive, or water from the cooling-water tank may be used, which should be treated before being sent to the boiler. The Krupp Company, Essen, Germany, which holds a Zoelly license, cleans the make-up water by sending it to a small evaporator. The feedwater evaporated in the evaporator escapes into the condenser, where it condenses and it is then sent to the boiler along with the condensate of the main circuit. Instead of leading the steam from the evaporator direct to the condenser, it is also possible to send it to a low-pressure turbine, or to a certain stage of the machine, thus doing useful work.

Neither of these two solutions has been resorted to on the experimental locomotive. The cooling water is used direct for boiler feeding, and is fed by the steam injector when necessary.

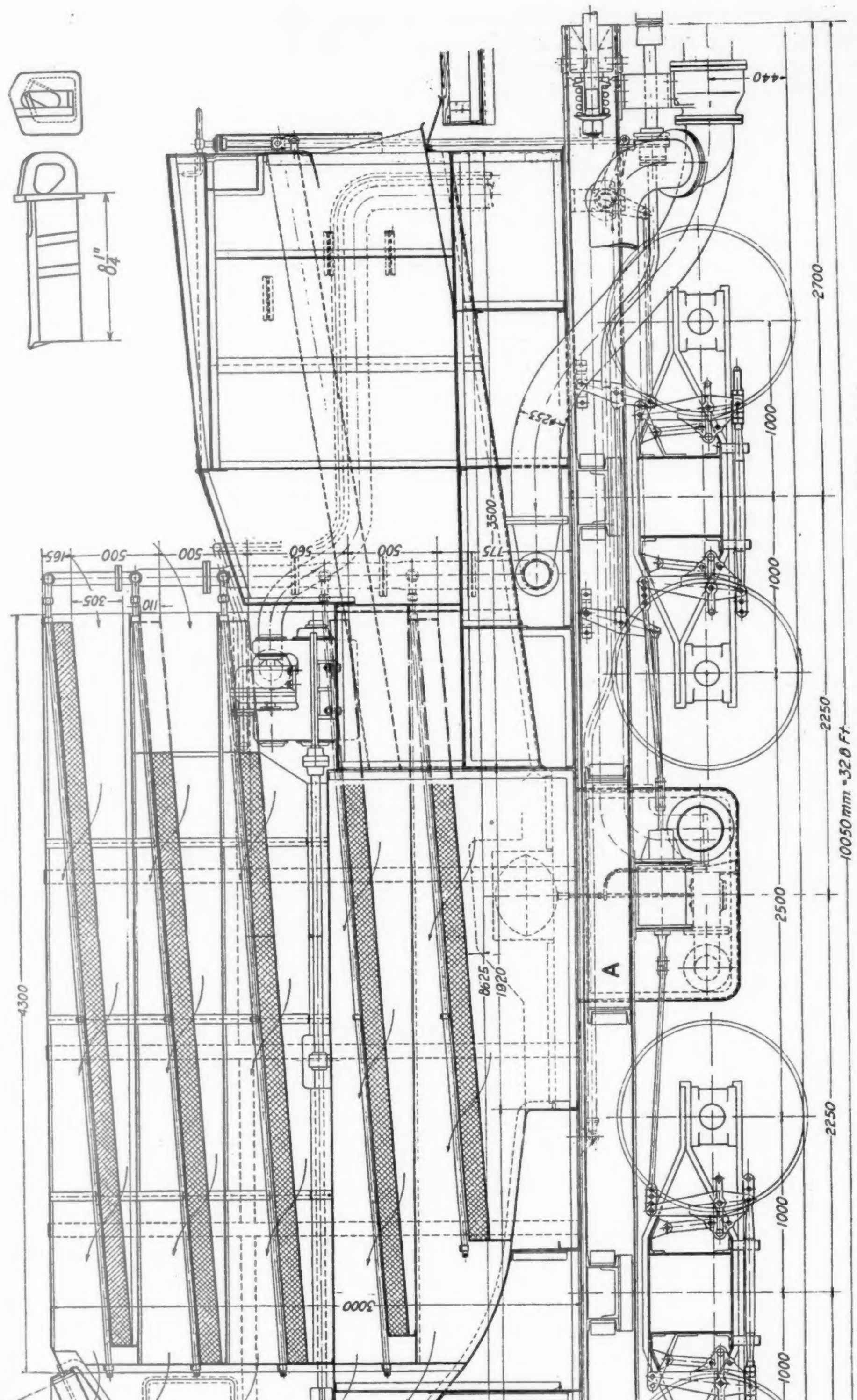
System of Lubrication and Recooling

Each turbine has its own lubricating system, comprising an oil tank and a geared pump driven from a shaft of the reduction gear. Gears and bearings are under forced lubrication, the oil for the main turbines passing through an oil cooler which is connected with the cooling-water circuit of the condensers.

The most vital part of the condensing locomotive, working with water as a refrigerating medium in the condenser, is the recooler. All the heat units taken from the steam in the condenser go to the cooling water, which of course, has to be recooled in order that it may be used in a cyclic process. The recooler is a separate vehicle, taking the place of the usual tender, and it provides room for coal and make-up water for boiler feeding. It works on the vaporization principle, air being brought into intimate contact with the water to be cooled, which heats it and saturates it with water vapor. The heat to be absorbed in such manner is enormous, amounting in the case of the 1,000-h.p. experimental locomotive to about 5,760,000 B.t.u. per hour, and increasing in proportion for larger locomotives.

The recooler comprises a certain number of water and air elements working in parallel. Each element consists of a wrought-iron channel of rectangular cross-section. This channel is divided diagonally into two halves in the longitudinal direction by means of perforated trays containing Raschig rings; i.e., small tubes of about equal length and diameter. The water to be cooled is led to these trays by tubes which act as sprayers, the air passing in counterflow. The cooling elements are so disposed that the natural current of air produced by the traveling train can enter the cooling element direct. A fan produces a sufficient current of air when the train is stationary or traveling at a very slow speed, and also augments the normal current when traveling at ordinary speeds. It is driven through a gear by a small back-pressure turbine, as previously mentioned. Admission of steam to the turbine is controlled by means of a valve from the enginemen's cab.

The cooled water flows from the cooling element back into a tank, whence it is again drawn into the circulating pump. As a certain amount of water is evaporated in the process it becomes necessary to add a corresponding amount in order to keep the circulating quantity constant. There is provided, for this purpose, a large storage tank on the tender, which communicates with a suction tank by means of floaters. The water in the tender need not necessarily be pure as it does not enter the boiler nor come into contact with such parts as could seriously affect the working of the plant.



Elevation Drawing of the Recooler for the Zoelly 1000-hp. Turbo-Locomotive (Dimensions Are in Millimeters)

Space is provided in the tender for 11 tons of coal and 1,440 gals. of water.

The recooler car and locomotive are coupled in the usual way. The connections for both the suction and discharge pipes of the cooling-water system are made by means of sliding ball-and-socket joints. These joints allow the tender to be uncoupled from the locomotive upon removing the coupling bolts. Connections for live and exhaust steam from the turbine which drives the fan of the recooler are only of small dimensions and are made by flexible pipes.

Theoretical Considerations

The Recooler—The vacuum obtainable determines the calculation of the turbines and auxiliaries; i.e., the better the vacuum, the greater the total heat which can be transferred to useful work. It is known from stationary plants that with surface condensers the vacuum depends directly on the cooling-water temperature. In the case of the condensing locomotive the vacuum, therefore, depends upon the temperature to which the cooling water can be lowered in the recooler.

The maximum temperature which the air going through the recooler can attain is that of the warm cooling water. If it be assumed that the air at this maximum temperature is fully saturated with water vapor, then the difference in total heat between the air entering and that leaving the recooler is identical with the amount of heat withdrawn from the water. When a turbine is working against different vacua it is possible, assuming definite initial steam conditions and constant turbine efficiency, to calculate the amount of heat which has to be extracted from the steam in the condenser or, what is the same thing, from the cooling water in the recooler. If it be further assumed that the vacuum in the turbine exhaust corresponds to the water-vapor tension of water at a temperature which is 41 deg. F. greater than the cooling water leaving the condenser, we can calculate the amount of air necessary to obtain a certain vacuum for a given quantity of steam. This calculation gives 59 deg. F., for cooling air and 70 per cent for saturated. The air necessary for cooling is delivered by a fan. Assuming a

constant surface area for the cooler for all the different vacua, the resistance through the cooler would of course, increase with the quantity of air, and the power required for driving the fan would augment with exceeding rapidity with better vacua. A long series of tests has shown that for full load the vacuum will be somewhere near 90 per cent, which of course, would only apply to maximum loads. On partial loads the vacuum would increase on the amount of steam sent to the condenser being less.

The Zoelly system of cooling involves the necessity of having a condenser and recooler, but affords important advantages. The co-efficient of heat transmission from steam to water in a surface condenser is about 490 B.t.u. per deg. F. per sq. ft. per hr., whereas that for air-cooled condensers from steam to air is only a trifle over 8 B.t.u. The surface of the air condenser must, therefore, be 60 times that of a water-cooled condenser. This makes it possible to have on the Zoelly locomotive, both condenser and turbines, on the same truck as the boiler, thus overcoming all difficulties involved in having vacuum connections between the tender and locomotive. The relatively small vacuum space is easily kept airtight, while the system further allows of the locomotive's being the real driving part, thus adhering to this extent to the old and conventional design.

It was, of course, impossible to calculate the recooler, and very extensive tests were necessary to clear up the very complicated relationships and to get the data for actual design. The complicated nature of the task of finding the most economical design; i.e., getting the maximum of cooling effect for a given surface with the minimum of weight and driving power, will be seen from the numerous variable factors; viz., material of the filling bodies, height, quantity of water, velocity of the air, distribution of water, water and air temperatures, etc. As a result of all tests it was found that for average conditions, that is, air 59 deg. F., cooling water 122 deg. F., corresponding to about 85 per cent vacuum, a cooling effect of 44,260 B.t.u. per sq. ft. per hour is obtained.

The Main Turbine—Superheated steam is used for turbine driven locomotives in any case, as this gives the highest efficiency. So long as it is necessary to use the conventional type of boiler it will scarcely be possible to assume other steam conditions than those obtaining for ordinary locomotives, say, 215 lb. pressure and 662 deg. F. The vacuum has been fixed in the preceding paragraphs and the desired output is given, so that, as variable factors in the turbine calculations there are the turbine speed, the wheel diameters, and the number of stages. These elements have to be chosen so that the efficiency will be as high as possible. On the locomotive we are limited in the matter of wheel diameters as well as in the number of stages. If these are determined the speed is dictated, any departure from which would mean a certain loss in efficiency, which within relatively wide limits, is not of the utmost importance. The turbine speed determines the gear ratio and dimensions. For normal conditions the turbine speed ranges from 6,000 to 8,000 r.p.m., but it also depends upon the maximum speed the train can attain, this in turn being limited by the stresses allowed.

A locomotive turbine has to be calculated not only for one particular speed and one load, as is usually done for stationary plants, but for different quantities of steam flow and for different speeds for each steam flow, in order to obtain full information as to the performance of the locomotive. For running astern a sacrifice in efficiency is admitted on account of the extreme limitation of space. The only point to consider is that sufficient initial torque must be available for accelerating the heaviest of trains.

The Auxiliary Turbines—The limitation in size and weight is very important, but efficiency is also exceedingly important. Small wheel diameters call for multiple stages and the turbine would thus be too long. In order to overcome this difficulty several turbines are connected in series. This arrangement in conjunction with high running speeds (9,000 to 10,000 r.p.m.) satisfies the demand for high efficiency combined with small dimensions.

Feedwater Heating—The heat contained in the smoke gases has long since been utilized in stationary plants, the economizer being a very well known device. Several feedwater heaters of this type have been tried for locomotives, but without success. The draft available in ordinary locomotives is not sufficient to overcome the additional resistance of such a heater. In turbine driven locomotives, however, where the draft has to be produced artificially, this difficulty does not present itself and, therefore, waste-gas feedwater heaters can be employed to advantage. The gases leave the stack with a temperature of about 750 deg. F., and can be cooled down to about 350 deg. F., thus giving 95 B.t.u. per lb., corresponding to about 1 lb. of feedwater. If the condensate leaves the condenser at a temperature of 122 deg. F., it will therefore be possible to heat the feedwater to 217 deg. F. The total heat of the steam in the boiler being 1,350 B.t.u., the saving effected by heating the feedwater thus amounts to 7.5 per cent.

TABLE I—COMPARATIVE STEAM AND COAL CONSUMPTIONS OF DIFFERENT LOCOMOTIVE TYPES

	Piston locomotives, non-condensing				Piston locomotives, condensing. Superheated-steam			Turbo locomotive. With feedwater heating		
	Superheated-steam simple 2-cyl.		Superheated-steam 4-cyl. compound							
	Without preheating	With preheating	Without preheating	With preheating	Simple. Without preheating	Compound. With preheating	Without preheating	With steam	With smoke gases	Preheating feedwater and combustion air
Boiler pressure, lb. per sq. in, abs.	213	213	213	213	213	213	213	213	213	213
Pressure at steam chest, lb. per sq. in. abs.	199	199	199	199	199	199	199	199	199	199
Temperature in steam chest, deg. fahr.	572	572	572	572	572	572	662	662	662	662
Exhaust pressure, lb. per sq. in. abs.	14.2	14.2	14.2	14.2	2.13	2.13	2.13	2.13	2.13	2.13
Steam per i.hp.-hr. (including all auxiliaries), lb.	16.97–16.28	16.97–16.28	16.5–15.61	16.5–15.61	13.83	11.55	10.59	11.08	11.08	11.08
Saving in steam consumption compared to simple locomotive working with superheated steam, non-condensing, lb.	0	0	0.47–0.67	0.47–0.67	3.14–2.45	5.42–4.73	6.38–5.69	5.89–5.20	5.89–5.20	5.89–5.20
Do., per cent	0	0	2.76–4.1	2.76–4.1	18.5–15.1	31.9–29.0	37.6–35.0	34.7–31.9	34.7–31.9	34.7–31.9
Total heat required in boiler per hp.-hr., B. t. u.	44,860–41,680	33,830–32,470	36,850–34,880	32,910–31,140	30,410	25,510	20,120	19,510	17,980	16,410
Coal consumption (heating value of 11,700 B. t. u. assumed), lb. per hp.-hr.	3.23–3.10	2.88–2.77	3.14–2.97	2.81–2.52	2.60	2.18	1.72	1.67	1.54	1.40
Saving in coal compared to a simple locomotive working with superheated steam and feedwater heating, lb.	—0.35 to —0.33	0	—0.26 to —0.20	0.07-0.25	0.28–0.17	0.70–0.59	1.16–1.05	1.21–1.10	1.34–1.23	1.48–1.37
Do., per cent	—12.4 to —12.1	0	—9.3 to —8.9	2.43-8.9	9.3–5.65	24.1–21.0	40.0–38.0	41.8–39.5	46.5–44.4	51.1–49.2

There are other possibilities of heating the feedwater with steam, which latter can be exhaust steam from auxiliary turbines or steam bled from the main or an auxiliary turbine. Steam being exhausted at atmospheric pressure from a back-pressure turbine, as in the case of the turbine driving the furnace fan of the experimental turbine, has a total heat of about 1,150 B.t.u. Were this steam used in a low pressure turbine working to the condenser, probably 72 B.t.u. could be transferred to useful work, but the steam would enter into the condenser with 1,080 B.t.u. of which 990 B.t.u. would go to the cooling water and thus be lost. Using the exhaust steam in the heater, all the 1,150 B.t.u. can be utilized. Under normal steam conditions the feedwater can be heated up to about 302 deg. F. The condensate having a temperature of 122 deg. F., we can, therefore, use 180 B.t.u. per lb. of feedwater. The maximum quantity of exhaust steam which can be utilized is accordingly one-fifth of the quantity of condensate. To heat up to this high pressure, of course, steam at a pressure higher than that of the atmosphere has to be used.

The greatest locomotive economy would be effected by preheating the combustion air with smoke gases and the feedwater with steam in a series of feedwater heaters, all heated by steam of different pressures bled from the main turbine or by exhaust steam at a suitable pressure. Steam bled from the main turbine or steam from the furnace-fan turbine will always be the most convenient, as the proportion of steam to feedwater is adjusted automatically.

Steam and Coal Consumption—The steam consumption of a turbine working condensing is very much less than that of a reciprocating engine working non-condensing. The condensing machines, however, require a number of auxiliaries also consuming steam and thus lowering the overall efficiency to a certain extent. In calculating the coal consumption, it is necessary to consider carefully what preheating system shall be employed as the coal consumption depends to a very great extent upon this factor.

Economies Shown by Tests

Tests have been conducted with this experimental locomotive, but only over a line of 35 miles which had variable grades. This made it impossible to make coal-consumption tests. All that could be determined was the steam consumption, which may be compared with that of a corresponding reciprocating locomotive making the same journey with the same load. Preheating was employed on the turbo-locomotive and only saturated steam was used for the auxiliaries. The consumption of heat in the turbo-locomotive for the round trip was only 4,230,000 B.t.u. An ordinary locomotive with the same train and identical operating conditions, will consume 5,904,000 B.t.u., calculated from the difference in water levels in the tender before and after the run and the initial steam conditions. These tests were repeated four times and the averages are given in Table I. The water consumption of the recooler was approximately 1,400 gals. Quite a large amount of this water represented mechanical losses through leakage.

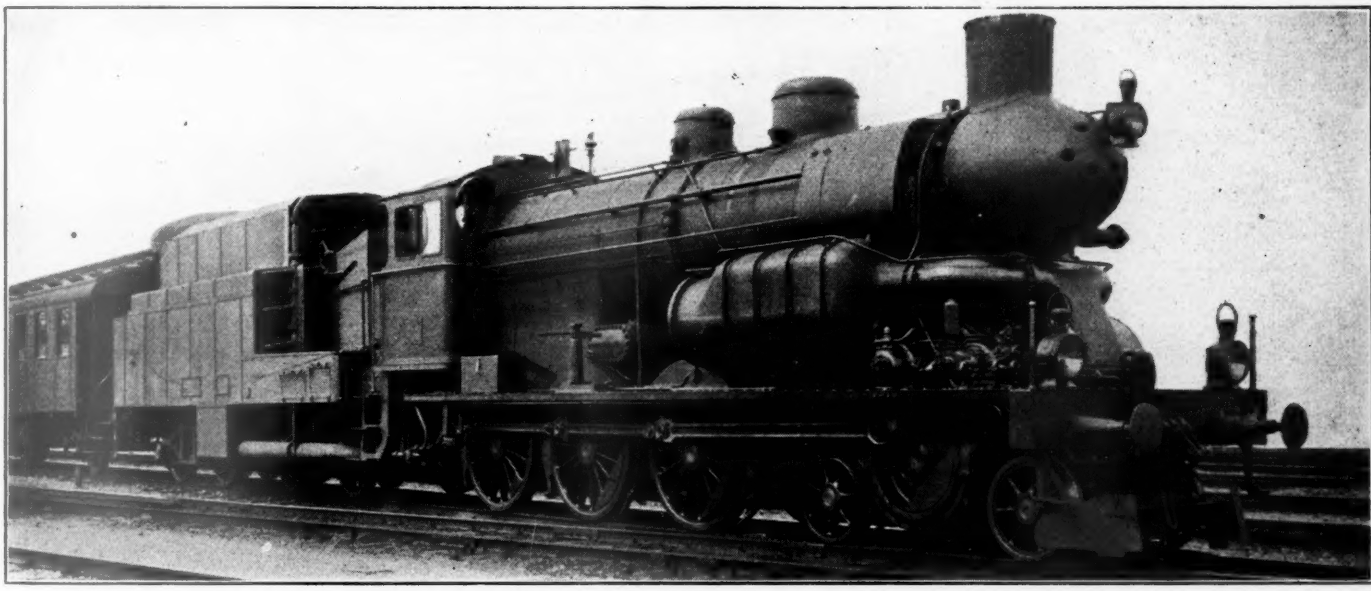
Operation and Maintenance is Comparatively Simple

In spite of the numerous parts comprising a turbo-locomotive, its operation is simple and less attention is required on the part of the personnel than is the case with the ordinary reciprocating locomotive. Before starting the locomotive the engineer speeds up the turbine driving the fan on the recooler.

This turbine is connected in series with the turbine driving the condensing auxiliaries and the condensing plant is started automatically. After the proper working vacuum has been attained, which requires several minutes, the steam-admission valve to the main turbine is opened wide and then it is only necessary to open or close the governor valve in order to start or stop the train. The exhaust fan should also be started as soon as the engineman starts to work the locomotive. The opening of this valve is governed in such a way that the boiler pressure is kept constant. Boiler feeding requires no attention from the engine crew, except to see that the pump is working properly. All that is required to keep the locomotive going at a certain speed is simply to throttle the steam admission to the required extent. If for any reason the output is insufficient when the governor valve is wide open, then the overload valve will allow an increase. The auxiliaries should not be shut down unless for a prolonged stop.

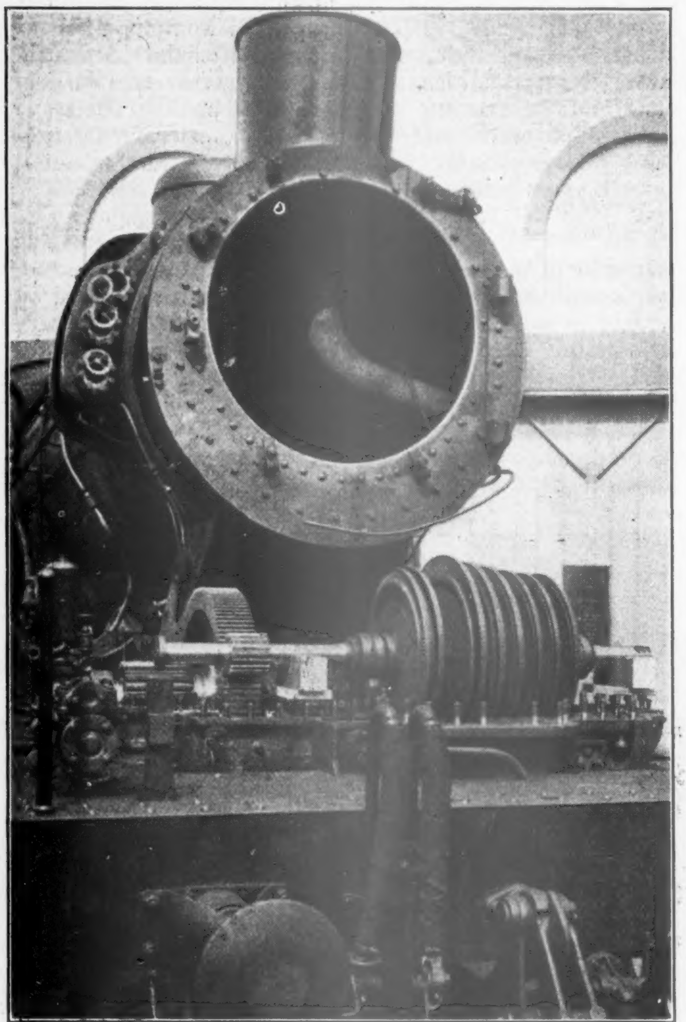
In order to run the locomotive backwards the valve for running ahead is closed and that for running astern is opened. The engineman then operates the governing valve as before.

The locomotive makes a smooth start which seems to contradict the opinion expressed by many engineers that a turbine-driven locomotive would not have sufficient initial



Standard 2-6-0 Reciprocating Type Converted into a Turbine-Driven Condensing Locomotive by Escher Wyss & Co., and the Swiss Locomotive Works

torque to start a train. The running of the turbine-driven locomotive is smooth when compared with that of a reciprocating locomotive. Dynamometer tests taken on the Swiss Federal Railways showed that the pull at the drawbar was free from fluctuations.



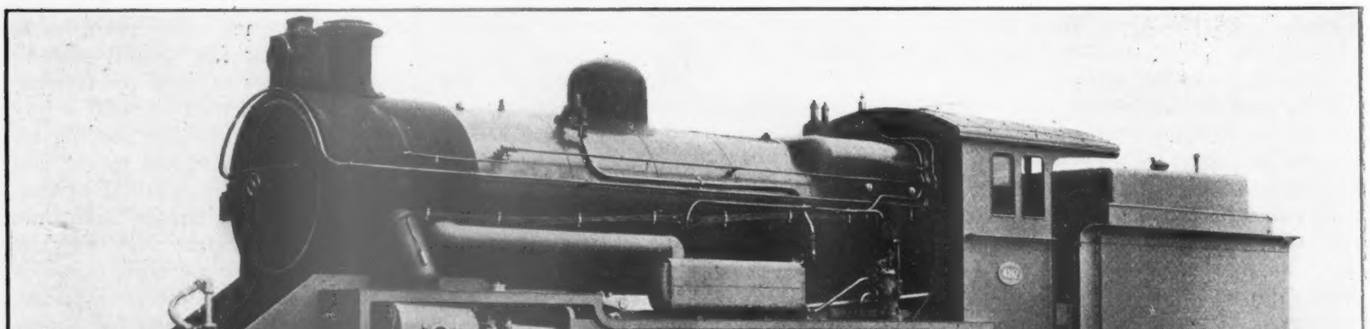
The Rotor and First Reduction Gear of the Zoelly Locomotive

A further development of the turbine-driven locomotive is at present impending which involves the employment of very high pressures. The practical utilization, however, depends upon the finding of a suitable boiler. As far as the turbine itself is concerned, the designs are ready.

The advantages of the turbo-locomotive are many. Some of them are, high economy in fuel, amounting to nearly 50 per cent; low water consumption and the water not necessarily being good boiler water; the boiler can be kept clean, and smooth running conditions obtained on account of the absence of reciprocating parts. It is predicted that the turbine-driven locomotive will soon enter into successful competition not only with the reciprocating locomotive but also with plans for electrification which are expected to result in greater efficiency in the utilization of coal. Its greater economy gives increased capacity with the same boiler and thus opens a new era of steam-locomotive traction.

Table of Dimensions, Weights and Proportions

Railroad	Swiss Federal Railways
Builders	Escher Wyss & Co., Zurich, Switzerland. Swiss Locomotive Works, Winterthur, Switzerland.
Service	Experimental
Turbine	6-Stage impulse Zoelly
Maximum speed, running ahead	7,500 r.p.m.
First gear reduction	1 to 7
Second gear reduction	1 to 4.1
Maximum speed	47 m.p.h.
Weights in working order:	
Total engine	130,000 lb.
On drivers	91,200 lb.
Wheel bases:	
Driving	12.3 ft.
Total engine	25 ft.
Total engine and tender	58.4 ft.
Wheels, diameter outside tires:	
Driving	60 in.
Front truck	33 in.
Boiler:	
Type	Conical
Steam pressure	200 lb. per sq. in.
Superheat	662 deg. F.
Fuel, kind	Bituminous
Grate area	25 sq. ft.
Heating surfaces:	
Firebox and combustion chamber	132.5 sq. ft.
Tubes and flues	927.5 sq. ft.
Total evaporative	1,060 sq. ft.
Superheating	380 sq. ft.
Comb. evaporative and superheating	1,450 sq. ft.
General data estimated:	
Turbine horsepower	1,000 hp.



12-Wheeled Locomotive Built for the Buenos Aires Great Southern Railway by Messrs Sir W. G. Armstrong, Whitworth & Co., Ltd., Manchester, England, Which Was Exhibited at the British Empire Exhibition

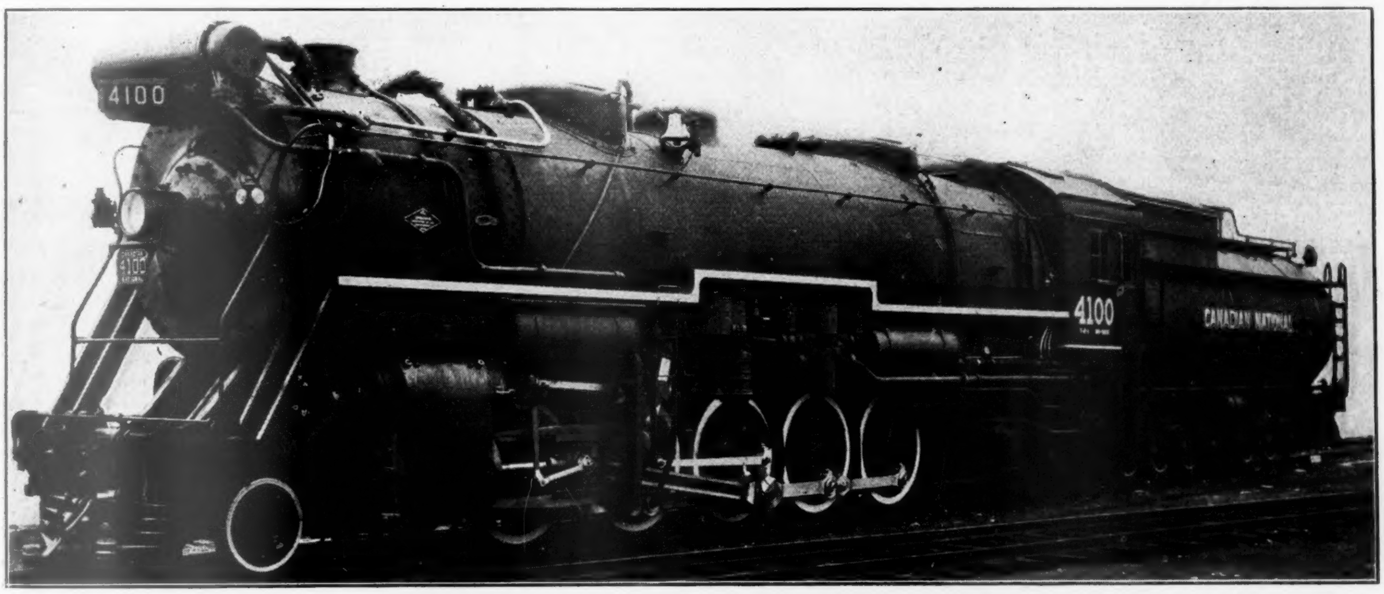
New Santa Fe Locomotives for the C. N.

Largest of Their Type in the World—Develop a Maximum Tractive Force of 91,735 pounds

By C. E. Brooks
Chief of Motive Power, Canadian National

THE Canadian Locomotive Company, Kingston, Ont., has recently delivered five Santa Fe type locomotives to the Canadian National. These locomotives are the largest in the British Empire and are also considered to be the largest of their type in the world. They were built for heavy transfer service between the Danforth and Mimico yards in the Toronto, Ont., terminal district, a distance of 12 miles with a maximum grade of 0.6 per cent going west and 1.2 per cent going east.

These locomotives are known on the Canadian National as the T-2-a class, road numbers 4100 to 4104. They have a total weight, without the tender, of 409,000 lb. The weight on the drivers is 321,000 lb. The tractive force, without the booster, is 80,200 lb., and 91,735 lb. with the booster. The cylinders are 29 in. by 32 in., and the driving wheels are 57 in. in diameter, with 50-in. cast centers.



Santa Fe Type Locomotive Built for the Canadian National by the Canadian Locomotive Works, Kingston, Ont.

The Boiler, Firebox and Attachments

The boiler is of the extended wagon top type with radial stays, conical bottom, and has a combustion chamber. The largest course is 104 in. in diameter. The boiler horsepower is 106.7 per cent of the cylinder horsepower on the basis of Cole's ratios. The flues are welded into the back tube sheet and the Canadian National's standard method of crown staying, similar to that used on the Mountain type locomotives, described in the August, 1923, issue of the *Railway Mechanical Engineer,* was carried out.

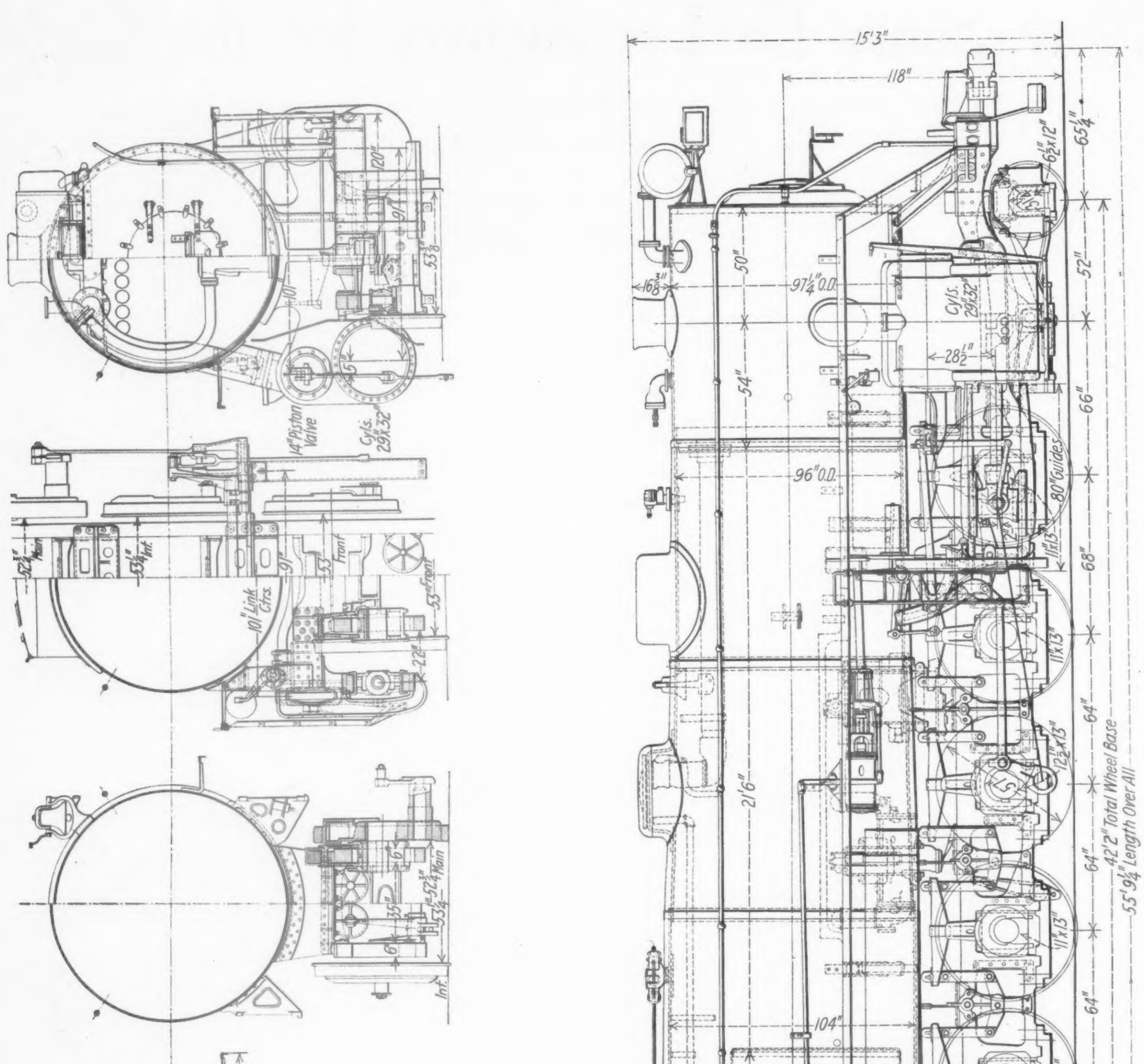
The locomotives are equipped with Duplex stokers and Elesco type feed water heaters, the drums of which are mounted on brackets on the front of the smokebox. Hancock non-lifting inspirators with 6,000 gallon tubes are located on the right-hand side.

The boilers are equipped with Type A superheaters and Franklin No. 9 fire doors. Steam for the boosters, with which the locomotives are equipped, is taken directly from the superheater header and the main shut-off valve is placed behind the stack.

The grates are of the Canadian National standard design, the rocking grate bars being of alloy cast steel with detachable lugs. The ashpans are of the center hopper type with an auxiliary hopper placed on each side of the engine outside of the trailing truck frame. These auxiliary hoppers are equipped with cast steel frames and doors and are designed principally to improve what would otherwise be a comparatively flat pan owing to the use of a Delta truck and booster. The Canadian National's standard sludge arrangement, consisting of a 1¼-in. pipe from the delivery pipe of the inspirator to the ashpan, with a valve which is operated from the cab and a branch extending into each hopper, is also applied. This arrangement has been found to be very serviceable during the severe winter weather encountered in Canada. In addition, an auxiliary ashpan blower is used, consisting of a ¾-in. perforated pipe across the back of the ashpan, which obtains its steam supply from the turret. This device is found desirable because the booster application and wide firebox somewhat restricted the slope of the pan at the back.

The Frame and Running Gear

The frames, with a single forward section, are made of vanadium steel, the rear end being fitted with a Commonwealth cast steel cradle casting. The wheels are fitted with brass hub liners. Hollow driving axles are used, the main journals being 12½ in. by 13 in. and the others 11 in. by 13 in. Grisco driving boxes have been applied at the main wheels, the feature of this box being a three-piece crown bearing fitted with a wedge adjustment. Lateral motion boxes have been applied at the front driving wheels and Franklin spreaders are applied to all boxes with the exception of the main drivers which are equipped with a cellar of



Elevations and Section of the 2-10-2 Type Locomotives for the Canadian National

special design. The crossheads are fitted with Rogatchoff adjustable wedges. The main rods and also the front and back intermediate rods are made of carbon vanadium steel. The back ends of the main rods are of the solid type and have floating bushings.

The engine truck is of the Economy two-wheel constant resistance type equipped with Preston hub slip liners. The wheels are 31¼ in. in diameter with spoked steel centers 25 in. in diameter. This type of wheels is common to all Canadian National freight locomotives of modern design. The journals are 6½ in. by 12 in. The trailing truck is of the Commonwealth constant resistant type, adapted to carry a booster with 43-in. wheels, 35-in. cast steel centers, and 9-in. by 14-in. journals.

Steam distribution is provided for by a Walschaert valve gear, the diameter of the piston valve being 14 in. The valves are set with a travel of 7 in., 1-3/16-in. lap, ⅛-in. lead, and line and line. A Precision power reverse gear is applied. The cab is of the Canadian National's short vestibule type of substantial construction securely riveted to the boiler with 3-in. by 4-in. angle iron around the front. In order to take care of expansion the cab brackets are designed to permit the cab to slide on the cradle casting. The railway company's standard turret, which was also described in the article on the Mountain type locomotives, to which reference has already been made, as well as the Hancock non-lifting inspirator operating valve, the blower valve and the stoker engine valve are placed outside the cab.

The sand boxes are fitted with Hanlon sanders. Three 3½-in. World type safety valves are used, one of which is muffled. The air brake equipment is of Westinghouse manufacture, in which is included one 8½-in. cross-compound pump. The headlight equipment consists of a Pyle-National turbo generator set and Keystone lamp case on both the front of the engine and at the rear of the tender, which are fitted with 14-in. Golden Glow reflectors. The Canadian National's standard separate number lamp is used on the front of the engine. The water level indicating device consists of the railway company's standard water column welded directly to the backhead to which are fitted the try cocks and water glass fittings. The water glass is fitted with the railway's closed type of protector. Steam is passed into the train heating lines through a World-Leslie reducing valve. The piston and valve rod packing is King metallic. The radial buffer and unit safety bar are used between the engine and tender, and the piping between the engine and tender is equipped with Barco joints. A Madison-Kipp four-feed mechanical lubricator is used for lubricating the valves and cylinders and a Nathan three-feed lubricator is used for the auxiliaries.

TABLE OF DIMENSIONS, WEIGHTS AND PROPORTIONS

Railroad	Canadian National
Builder	Canadian Locomotive Company
Type of locomotive	2-10-2
Service	Freight
Cylinders, diameter and stroke	29 in. by 32 in.
Valve gear, type	Walschaert
Valves, piston type, size	Piston, 14 in.
Weights in working order:	
On drivers	321,780 lb.
On front truck	28,780 lb.
On trailing truck	58,680 lb.
Total engine	409,240 lb.
Tender	245,800 lb.
Wheel bases:	
Driving	21 ft. 8 in.
Total engine	42 ft. 2 in.
Total, engine and tender	80 ft. 9¾ in.
Wheels, diameter outside tires:	
Driving	57 in.
Front truck	31¼ in.
Trailing truck	43 in.
Boiler:	
Type	Ext. wagon top
Steam pressure	200 lb. per sq. in.
Fuel, kind	Bituminous
Diameter, first ring, inside	94½ in.
Firebox, length and width	120 in. by 96¼ in.
Combustion chamber, length	45½ in.
Tubes, number and diameter	264—2¼ in.
Flues, number and diameter	50—5½ in.
Length over tube sheets	21 ft. 6 in.
Grate area	80.3 sq. ft.
Heating surfaces:	
Firebox and arch tubes	356 sq. ft.
Tubes and flues	5,178 sq. ft.
Total evaporative	5,534 sq. ft.
Superheating	1,558 sq. ft.
Comb. evaporative and superheating	7,092 sq. ft.
Tender:	
Water capacity	11,000 Imp. gallons
Coal capacity	16 tons
General data estimated:	
Rated tractive force, 85 per cent	80,200 lb.
Rated tractive force with booster	3,025
Cylinder horsepower (Cole)	3,200
Boiler horsepower (Cole) (est.)	91,735 lb.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	78.5
Weight on drivers ÷ tractive force	4.01
Total weight engine ÷ cylinder hp	135
Boiler proportions:	
Comb. heat. surface ÷ cylinder hp	2.34
Tractive force ÷ comb. heat. surface	11.32
Tractive force × dia. drivers ÷ comb. heat. surface	644
Cylinder hp. ÷ grate area	37.65

Tender Design

The tank is of the Vanderbilt type and is the first of its kind to be used in Canada. The water capacity is 11,000 Imperial gallons and the coal capacity is 16 tons. The tank is carried on a Commonwealth cast steel tender frame and six-wheel tender trucks with 34¼-in. steel tired wheels and semi-steel center 28 in. in diameter and 5½-in. by 10-in. journals. The trucks are equipped with clasp brakes.

This locomotive has maintained in actual service a drawbar pull of 77,000 lb. to 79,000 lb. on a one per cent grade. The important proportions and dimensions are in the table.

Setting Valves Without Plus or Minus Signs

By L. R. Linn

Supervisor of Apprentices, Duluth, Missabe & Northern, Proctor, Minn.

A MAJORITY of valve setters would probably prefer using methods for figuring valve changes that do not involve the use of the plus and minus signs, especially if changes have to be made in the formulas for various designs of gear.

To a great many persons who study valve setting, the divisor four seems to be an arbitrary figure, the derivation of which they cannot comprehend. The formula in the article by H. W. Stowell, on page 596 of the October issue of the *Railway Mechanical Engineer*, gives the derivation of this figure but to make it comprehensive to the machinist or apprentice it seems to me that the formula should be shown solved step by step. Taking the equation $a - b = c - d$ to determine the necessary change of the valve, effected by a change of the eccentric rod, letting x equal the change of the valve and solving step by step, we have:

$$a - b = c - d$$
$$(a+x)-(b-x)=(c-x)-(d+x)$$

Removing parentheses, and collecting like terms by transposing:

$$4x = b + c - a - d$$
$$x = \frac{(b+c)-(a+d)}{4}$$

This result must ot course be multiplied by the ratio, as explained in the recent article referred to, to ascertain the necessary amount of change in the eccentric rod.

Let us now take the equation for figuring the valve stem

change, letting x equal the required change and solving step by step:

$$a-b=d-c$$
$$(a+x)-(b-x)=(d-x)-(c+x)$$

Collecting like terms, combining and re-arranging:

$$4x=b+d-a-c$$
$$x=\frac{(b+d)-(a+c)}{4}$$

An arbitrary rule is one that holds good for one condition and must be revised for another condition and such is the case in determining the direction of the change of the eccentric rod by the plus and minus signs.

It may be assumed that any person setting valves or interested in valves, knows when a motion is direct or when it is indirect, and that a change in the length of the eccentric rod will move the foot of the link, or the gear connecting rod, depending on the type of valve gear used, forward or back, agreeing with the change made on the eccentric rod.

Let it first be determined, by examination of the figures, whether the foot of the link should be brought forward or back to give the desired change on the valve. With this determined, the change of the eccentric rod is obvious. The foot of the link would be moved in the same direction as the valve with direct motion and in the opposite direction as the valve with indirect motion. With this in mind let us now consider another method of figuring eccentric rod changes that may be followed for any arrangement of valve gear and that does not bring into use the plus and minus signs but merely calls for the exercise of a little reasoning ability.

Adopting the conventional form for representing the condition of the valve gear and letting the arrow indicate the front of the engine, we have:

a | | b forward motion
$\longrightarrow$
c | | d back motion

With an eccentric rod change on a valve gear direct in one motion and indirect in the opposite motion it is evident that like changes will result at opposite ends of the valve for the forward and backward motion; that is, if a is to be increased, d will be increased an equal amount and b and c will be decreased by the same amount. Adding the two sets of figures that have like changes, then subtracting the lesser sum from the greater and dividing by four, will give the value of x in the formula.

Let us illustrate by a definite case. Suppose the following condition exists:

$\frac{1}{4}$ | | $\frac{3}{8}$ forward motion
$\longrightarrow$
$\frac{5}{8}$ | | 0 back motion

$$\tfrac{1}{4}+0=\tfrac{1}{4}$$
$$\tfrac{5}{8}+\tfrac{3}{8}=8/8$$

Subtracting the lesser from the greater we have:

$$8/8-\tfrac{1}{4}=6/8$$

Dividing by 4, we have:

$$x=6/8\div 4=6/32 \text{ or } 3/16$$

The amount to change the eccentric rod is 3/16 times the ratio for this particular gear.

A Method to Determine Whether to Lengthen or Shorten the Eccentric Rod

Observe whether the back-up or forward motion has the greatest difference, thus:

$\frac{3}{8}-\frac{1}{4}=\frac{1}{8}$ difference in forward motion.
$\frac{5}{8}-0=\frac{5}{8}$ difference in backup motion.

Change the eccentric rod to favor the motion with the greatest difference, in this case the back-up motion, and the valve should be moved back, always toward the greatest figure, which would call for the foot of the link to come ahead if the back-up motion is indirect, or come back if the back-up motion is direct. With a valve rod change it is evident that like changes will result at the front ports of both motions and like changes will result at the back ports of both motions, but opposite to the changes at the front ports; that is, if b and d are increased, a and c will be decreased or vice versa. Adding the figures at b and d and also those at a and c, and then subtracting the lesser from the greater and dividing by four will give the value of x in the formula for the valve stem.

Using as an illustration the assumed definite case, we have:

$$\tfrac{3}{8}+0=\tfrac{3}{8}$$
$$\tfrac{1}{4}+\tfrac{5}{8}=\tfrac{7}{8}$$

Subtracting the lesser from the greater, we have:

$$\tfrac{7}{8}-\tfrac{3}{8}=4/8$$

Dividing by 4 we have:

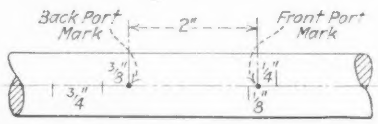
$$x=\tfrac{1}{8}$$

No ratio is used here as the valve is moved 1 to 1 with the change of the valve stem.

To determine whether to lengthen or shorten the valve stem add the two front figures, b and d, also the two back figures a and c, and make the change to move the valve toward the greater sum, thus:

$$\tfrac{3}{8}+0=\tfrac{3}{8}$$
$$\tfrac{1}{4}+\tfrac{5}{8}=\tfrac{7}{8}$$

The back figures would give the greater sum which indicates that the valve must be moved back, as the object of valve setting is to have equal figures at the four points. Thus it will be seen that the valve rod must be shortened.



The Position of Each Valve Event Scribed on the Valve Stem

To eliminate a minus sign when the tram falls between the two port marks as shown in the illustration, we may measure from the tram marks to the farthest port mark, obtaining the following measurements:

$2\frac{3}{8}$ | | $2\frac{1}{4}$
$\longrightarrow$
$2\frac{3}{4}$ | | $1\frac{7}{8}$

Figuring x for the eccentric rod change:

$$2\tfrac{3}{8}+1\tfrac{7}{8}=4\tfrac{1}{4}$$
$$2\tfrac{1}{4}+2\tfrac{3}{4}=5$$

Subtracting the lesser from the greater:

$$5-4\tfrac{1}{4}=\tfrac{3}{4}$$

Dividing by 4 gives us:

$$x=\tfrac{3}{4}\times\tfrac{1}{4}=3/16$$

Figuring x for the valve rod change:

$$2\tfrac{1}{4}+1\tfrac{7}{8}=4\tfrac{1}{8}$$
$$2\tfrac{3}{8}+2\tfrac{3}{4}=5\tfrac{1}{8}$$

Subtracting the lesser from the greater:

$$5\tfrac{1}{8}-4\tfrac{1}{8}=1$$

Dividing by 4 gives us:

$$x=\tfrac{1}{4}$$

The eccentric rod will be changed to favor the backup motion as the greatest difference exists in this motion. The valve rod will be shortened so as to pull the valve back, as the greatest sum is at the back end:

Proving the Results

After changing the eccentric rod the figures will be as follows:

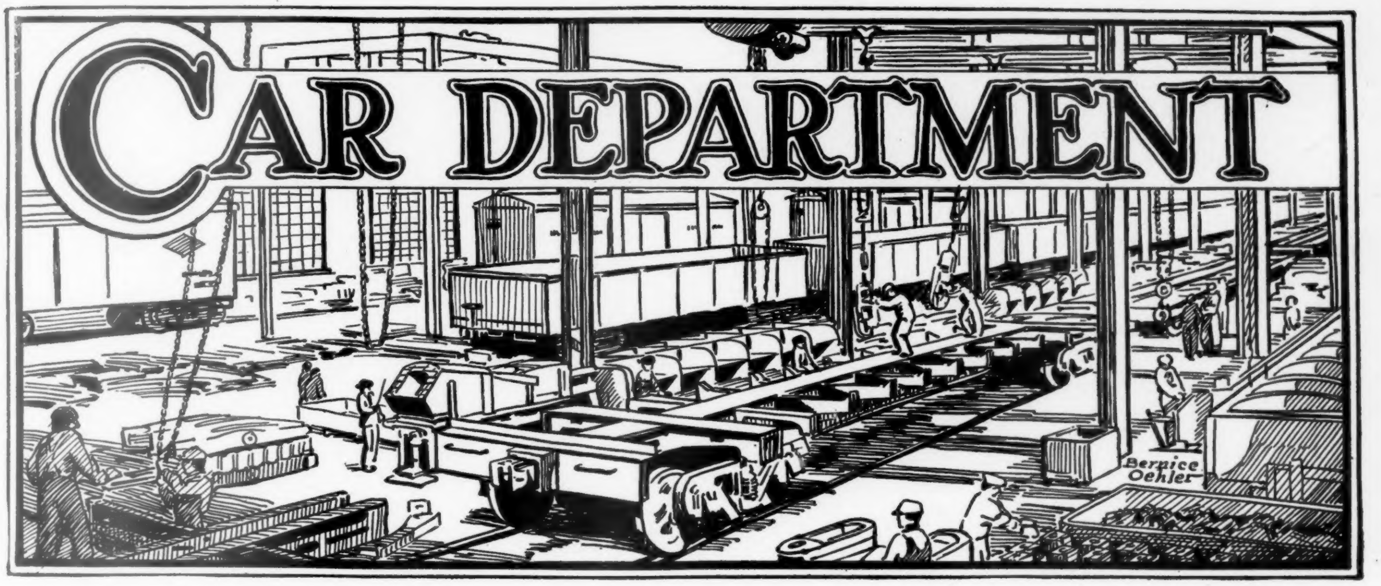
2 9/16 | | 2 1/16
$\longrightarrow$
2 9/16 | | 2 1/16

After changing the valve rod the figures will be as follows:

2 5/16 | | 2 5/16
$\longrightarrow$
2 5/16 | | 2 5/16

The two inch measurement between the port marks may now be subtracted from each figure if desired, which would give:

5/16 | | 5/16
$\longrightarrow$
5/16 | | 5/16



Discussion of New Car Interchange Rules

Extensive Debate on Application of Rule 32—Question Raised as to Proper Credit for Scrap Wheels

AT the twenty-third annual convention of the Chief Interchange Car Inspectors' and Car Foremen's Association of America, held at the Hotel Sherman, Chicago, September 23, 24, and 25, the new rules of interchange were discussed at length. Below will be found an abstract of the discussions relating to the changes to become effective in the new rules.

Rule 2

T. S. Cheadle (R. F. & P.): I would like to ask a question on paragraph 6 of Rule 2. That is in connection with 25 per cent of roof boards. Does that mean a wooden roof or does it mean a metal roof?

J. J. Gainey (Southern): The rule is plain on that. It says roof boards.

I was at a terminal not long ago where the car foremen were in dispute, also the chief interchange inspector, claiming that an arch bar was passed just the same as a metal truck side in interchange. I would like to know what the members of this association think about it.

A. F. Owen (L. & N.): In what way was it cast, the same as a cast steel truck side?

Mr. Gainey: If it was a broken arch bar they claimed they could reject the car or transfer it just the same as they could for a metal truck side.

Mr. Owen: The way I understand the rule they cannot. A cast steel truck side delivered to an owning line if transferred is an owner's responsibility. If delivered to a foreign line it is a delivering line responsibility. Whereas an arch bar is supposed to be repaired by the receiving line while the car is under the load.

A. Armstrong (Southern): Section 3 is very plain, "all other defects on foreign cars except." Arch bars are not mentioned.

Mr. Cheadle: The same question was raised in my territory, and answered in accordance with the interpretation on page 13 of the Rules. The receiving line has the right to refuse any car which it judges unsafe for movement on the line. The receiving line has a right to reject under that rule.

A. Herbster (N. Y. C.): This has reference to loaded cars interchanged only, I presume, as I do not believe anybody would be taking an empty car with a broken arch bar. There are arch bars of peculiar construction. Some are pressed steel and others channel arch bars. It may enter into a case of wrong repairs with some road and perhaps that is why they are refusing the cars.

M. E. Fitzgerald (C. & E. I.): The Committee on Car Construction have designed an A. R. A. standard arch bar and the rule plainly indicates that if the car is delivered to you with a broken arch bar it is up to you to repair it. You will not make wrong repairs if you apply the A. R. A. standard to that car.

T. J. O'Donnell: May I refer to Rule 2 on inside door protection? What do we do with the small end doors? What do you do with the automobile double doors? How are you going to keep your load in?

W. R. Rogers (Youngstown, O.): It is very evident that the railroad making the adjustment and applying the door protection is to be paid for the work regardless of whether or not the guilty road is penalized. On the face of the interpretation it appears that the road that can best afford to pay for it, that is, the road earning the revenue or in other words, the *road haul road* pays the bill notwithstanding the fact that they are not the road originating the load, in other words, "Not Guilty But Pay the Costs." The intent of the rule was to penalize the originating road for their failure for not compelling the shipper to comply with the loading rules, but the interpretation, to some extent at least, defeats the intent and purpose of the rule, as in many cases the trunk line originating the load acts as a switching road either on an actual cost basis or a reciprocal cost, and in such cases the road haul road has no redress, that is, the shipment not originating on their line they cannot themselves compel the shipper to use door protection. The road haul road is told that they can make settlement with the

switching line by special arrangement, in other words, "Try and Get it."

Had the answer to question 4 read, "Bills should be made against the road haul line using the original billing, the road haul line to make counter-bill against switching line unless special arrangements are made to the contrary," it would, in my opinion, place the responsibility where it rightly belongs.

The first paragraph of Loading Rule 34 makes it compulsory to secure lading (brace and block it) so that it will not come in contact with side doors or roll or shift in transit.

The second paragraph of that rule provides that lading of a "Character" requiring protection to prevent it falling or rolling (it does not say "shifting") out at door way or coming in contact with door while in transit must have the prescribed stripping across the door opening. In other words if the lading is of a character that it is not practicable to brace and block it, and it is liable to fall or roll against door, then the door ways are to be stripped as provided in the third paragraph of that rule.

The last paragraph of Rule 34 requires that lading loaded in vehicle cars with end doors must be securely protected against end shifting and loaded in such a manner that lading will not come in contact with end doors. In other words, it is the lading that is to be protected against end shifting, brace and block it or load it in such a manner as to prevent shifting. The rule does not make any attempt to provide end door protection as it does for side doors. The protection as provided for side doors would be useless if used to prevent lading from longitudinal shifting against end doors.

Where the loading rules specifically cover, as in the case of tires, wheels, barrels, etc., or brick when not loaded in the specified manner, if the lading has not shifted or come in contact with the doors, and door protection is omitted, it is my opinion that the protection can be applied at the expense of the originating road.

In cases where the loading rules do not specifically cover, I believe that the lading would have to require adjustment before a bill would be justified, for the reason that the originating road is always responsible regardless of whether discovered at an interchange point or on the road. In other words, the intermediate road is protected if necessary to adjust load. I would consider it sharp practice to permit inspectors to open up the side doors unless there was a very good reason for it (doors showing stress of load against it).

Mr. O'Donnell: If you put a load of lumber in one of those cars, and the shipper fails to brace and block it, who is going to pay for it?

Mr. Rogers: With me the original road is responsible for it, but you have got to brace and block that kind of a door. Make the delivering line responsible for the shifting of the load.

Mr. O'Donnell: I won't do it. We are delivering about thirty or forty cars a month, I should say, and they are accepting all of ours. We will take that as settled.

Mr. Cheadle: Before you get off this question of door protection, I want to say this: On our line it has given us a tremendous amount of trouble, in connection with the collection of bills. We, of course, have the rule of the Committee, but I understand that in over 50 per cent of the cases where bills have been rendered, questions have been raised.

Our road has also received from one road a circular saying that they would not pay or accept charges for such work. We do not charge for door protection except where the door is under distress, and only where we apply the door protection from the inside. If it is applied from the outer side, it is classed as temporary repairs and no charge is made except for the handling line. We do not charge for shifted lumber. If a car with an end door is to be loaded with a commodity that would roll and fall, we do apply for door protection whether they are large or small end doors. Of course, the majority of railroads, I presume, handle those bills entirely through their traffic department, but with my line, the work of adjustment is done entirely by the mechanical department. Therefore, that is why, I presume, I am the only one here who knows we are having trouble in this particular manner.

Mr. O'Donnell: When you have just labor, applying no material, do you charge for it?

Mr. Cheadle: No, we do not.

Mr. O'Donnell: I think the late rules tell us that lumber, I think it is less than eight or ten feet, will get to the end door which becomes in distress. We can charge the originating line for such lumber. If it is long lumber, the whole length of the car, we can not charge for it.

I am going to answer Mr. Cheadle on the question of refusing bills. Mr. Hawthorne tells me that our arbitration committee is working on that, and I believe in the near future they will make it mandatory.

I recommended in my talk that instead of these bills being handled through the auditor, superintendent and general manager, they should be referred to a car man, either a general car foreman or master car builder, and his knowledge of the shifting of load in box cars will indicate to him right away whether the bill should be accepted. Now, the operating department is shooting them back and forth without any instructions.

Secretary Sternberg: I will say for Mr. O'Donnell's information that on our road all of those bills are handled through our office and that of the superintendent.

Mr. Lynch: It is generally understood, according to the rule, that the road originating the load is responsible for the proper loading of the car. There is an interpretation to the rule concerning the road on which the shipment originates and where it is given to another carrier, and that rule complicates the matter a good deal.

I want to give you an example, using the numerals 1, 2, and 3 instead of the names of the roads. Road 1 loaded a car at East St. Louis. It was handed over to Road 2 which hauled it to Cairo, Illinois, where it was handed over to Road 3. The latter hauled the car into Cleveland and delivered it to Road 4. The doors were found in distress and the necessary note was attached and the work done. Now, in that case, both roads had a road haul on the shipment. Which road is responsible, Number 2 or Number 1? This is simply an example of what the interpretation means in regard to relieving the road originating the load from responsibility, in case it is acting as agent for the carrier.

Mr. Schultz: That very thing brings about the refusal of a great many of these bills. A road waybills the load out. As the shipment proceeds it goes on the original bill to destination, and the information we have to furnish is what we get from the waybill. If a switching line has an organization which bills out the freight loaded on their line, naturally the bill goes against them, and practically all the trouble you have in collecting these bills is because of lack of information. They never knew they had the load, in some cases. In other words, they say they never loaded the car. A load will be loaded on the Coast, for example, go about half way across the continent and the man who rebills it does not show the originating road. The information shows that the intermediate line loaded the car when, in fact, it was handled by two previous lines. I question whether our method of collection in this manner is going to be a success.

Mr. O'Donnell: We have a ruling, Mr. Chairman, that the road furnishing the bill is responsible for the door protection. In our district we have a switching road. They furnish no bill. The bill simply goes to the carrying line. Now, if two trunk lines are interested, we will say the Erie and the Nickel Plate, and a car of fertilizer is loaded on the Erie. The Erie has nothing to do with the car, so far as doorway protection is concerned, under this rule. The

Nickel Plate furnishes the door protection and takes care of the labor.

Mr. Rogers: In the city of Youngstown, we have four large trunk lines acting as switching agents for each other. Just as Mr. Lynch says, the Pennsylvania may originate the load, the Erie may get the haul, and consequently in this case the Erie may have the door protection. They have no redress. They cannot go to the shipper and say, "Put in your door protection." The result is this, they are penalizing the wrong road.

Mr. O'Donnell: I agree with Mr. Rogers logically. It has always been our custom heretofore, before this rule on door protection was adopted, to charge the loading line. The powers that be have ruled, however, that the person furnishing the bill is responsible for the lading, so far as that part of it is concerned.

The Committee recommends that the effective date of the second paragraph of Section (b) be extended to January 1, 1926, the paragraph to be modified in accordance with proposed form shown below.

PROPOSED FORM—After *January* 1, 1926, cars equipped with couplers having riveted yoke without lugs, *where such yokes are riveted directly to the coupler,* will not be accepted in interchange.

Section (e) tank cars, the safety valves *or tanks* of which are due for test within 30 days, will not be received from owners.

Tank cars (empty or loaded), will not be accepted in interchange unless they comply with the A. R. A. Tank Car Specifications, *with the following exceptions:*

Loaded tank cars tendered for shipment must be inspected by the carrier before acceptance, to see that they are not leaking; that the air and hand brakes, journal boxes, trucks and safety appliances are in proper condition for service; and that the *car* has been tested within limits prescribed by American Railway Association specifications for tank cars. Safety valves on tank cars must not be tested while these cars are *loaded*. Whenever *the test of safety valve or tank* is due on the loaded car *while* in transit, *unless the car is leaking or in a manifestly insecure condition, it must be forwarded* to destination carded on both sides as follows:

(1) When loaded with dangerous articles—

Safety Valves } overdue for test.
Tank }
Moving under I. C. C. 402.

Prompt report of such movements, showing initials and number of car, must be made by railroads carding the cars to the Chief Inspector, Bureau of Explosives, 30 Vesey Street, New York City.

(2) When loaded with non-dangerous articles—

Safety Valves } overdue for test.
Tank }
Moving under A. R. A. Interchange Rule 3, Section (e).

(3) *Empty tank cars when consigned to owner or lessee for test of tank.*

Safety Valves } overdue for test.
Tank }
Moving under A. R. A. Interchange Rule 3, Section (e).

Mr. Trapnell (C. I. I., Kansas City, Mo.): Of course that is quite a concession to give them, and while it tells you that you cannot receive the car from the ower it makes provision whereby you can move it.

Mr. O'Donnell: Do you move it away from the owner's line, the owner's plant?

Mr. Trapnell: I could not say that because I do not intend to be incriminated, but they get on the line somewhere.

Mr. O'Donnell: I think that we ought to be consistent in this. Either loaded or empty cars from the owner should not be accepted. That is the trouble. They get down in our district and we are up against it. There ought to be more observance of the rule at the owner's gateway. We absolutely refuse to take them from the owner, loaded or empty.

The Committee recommends that the effective date of Section (i) be extended to January 1, 1926, and that the section be modified as follows:

(i) After *January* 1, 1926, cars will not be accepted from owner unless equipped either with *steel underframe*, wooden or metal draft arms extending beyond the body bolster, or metal draft arms extending to metal body bolster and securely riveted to same.

The Committee recommends that the effective date of the second sentence of Section (1) be extended to January 1, 1926, as follows:

All flat cars that can be used for twin or triple shipments of lading, built after January 1, 1918, must have side stake pockets spaced minimum 2 ft. 0 in. and maximum 4 ft. After *January* 1, 1926, no flat car that can be used for twin or triple shipments will be accepted in interchange unless the side stake pockets are so spaced.

The Committee recommends the addition of a new section to Rule 3, to be designated as Section (q) as follows:

On and after January 1, 1926, no car will be accepted from owner unless equipped with an efficient auxiliary device for supporting brake beam in case of failure of brake hanger or hanger support.

The Arbitration Committee will also recommend to the Committee on Car Construction that it define what constitutes an efficient auxiliary device and manner of application.

The Committee recommends the addition of a new section to Rule 3, to be designated as Section (e) as follows:

"Cars built new after January 1, 1926, or new cars contracted for after January 1, 1925, will not be accepted from owner unless equipped with steel underframe meeting A. R. A. strength requirements.

Rule 14

C. F. Straub (Reading): There seems to be a confusion in different parts of the country about the proper designation on such cars or principally self-clearing hopper cars that have the empty and load brake that the brake cylinder rigging is at the *A* end of the car and the brake shaft is also at the *A* end of the car, but the cylinder operates towards the opposite end. Invariably inspectors get confused in claiming that repairs made at the *A* end were actually at the *B* end. It seems to me that is a proper question to get in the minutes so that the end to which the cylinder rigging is constructed is known as the *A* end. Many inspectors get it just the opposite.

Mr. Herbster: The end towards which the piston travels is always considered the *B* end. The location of the cylinder brake shaft or reservoir has nothing to do with the location of the end of the car.

Rule 17

The Committee recommends the following modifications of Interpretation 7 under this rule:

Interpretation 7 is the cause of complications, owing to difficulty in determining whether the patented brake connectors referred to are a standard of the car owner. A modified interpretation, to correspond with the regular practice of charging patented pressed steel journal boxes, would simplify the numerous billing transactions.

A.—The conditions are such as to justify a broad ruling on the basis of sections (b) and (f): Therefore, effective July 1, 1924, the material referred to, when conforming to A. R. A. standard, and subject to Rule 105, may be charged at stores department cost when applied in repairs to foreign cars on and after that date.

REASON—To clarify the rule.

The Committee recommends an additional interpretation (18) of this rule, as follows:

Q.—Is equipment stenciling required on cars for certain details, such as Type "D" Couplers and K1 or K2 Triple Valves, where the stenciled date built definitely established the standard of car?

A.—No.

REASON—To clarify the rule.

Mr. Owen: I would like to bring up a question under Rule 17, Item (b), on page 32.

It is permissible under that rule to substitute wrought iron for cast steel or malleable iron A. R. A. standards. In my opinion that rule should be extended to cover items that are not A. R. A. standard, such as wrought iron carry irons, brake hangers, brake hanger keepers, truss rod bearings, etc. Some railroads have malleable; some have cast steel carry irons, brake hangers, brake hanger keepers. They can all be forged in about the same design of equal strength, if not better, out of wrought iron. If you forge those items out of wrought iron to apply to a foreign car it is necessary that you issue a defect card, and yet they are all owner's responsibility. You would not be justified in holding up this car and ordering the cast steel carry iron from the owner when you could easily forge one and get the car moving the same day.

To expedite the movement of cars I would recommend that on such items as that their carrying point be allowed to use wrought iron and it would not be considered as wrong repairs.

Mr. Fitzgerald: We have already got a rule that protects the repairing line in connection with those items mentioned. Rule 88. You can substitute wrought iron and give the owner a defect card for labor only.

W. P. Elliott (Term. R. R. A. of St. Louis): Where is the protection?

Mr. Fitzgerald: Render a bill against the car owner for the material you put on the car. You give a defect card for the labor of correcting. He is entitled to it.

Rule 20

The Committee recommends that the second paragraph of this rule be changed as follows:

"When construction of car and trucks precludes the common methods of adjusting coupler heights, the application of metal shims, between journal boxes and arch bars *or truck sides* will be permissible."

Mr. Trapnell: We have done it for a long time. Now we are just getting absolute authority to do it.

Rule 30

The Committee recommends that Section (c) be changed as follows:
Wooden and steel underframe cars (except refrigerator cars) should be reweighed and remarked *once each twelve months during the first twenty-four months* the car is in service and thereafter once every twenty-four months. All-steel cars and all refrigerator cars should be reweighed and remarked at least once every thirty-six months. Such reweighing and remarking may be done after expiration of eighteen months (for wooden and steel underframe cars) and thirty months (for all-steel and all refrigerator cars) from the month in which previous weight was obtained. This paragraph does not apply to tank cars.

Mr. Trapnell: In other words, you bill the car on December 1 and on January 1 under the old rule you could reweigh the car and bill the owner. Now they put it in months. A certain number of months must elapse before you can penalize.

The Committee recommends that Section (f), Item 10, first paragraph, of this rule be modified as follows:
The weights of the car so obtained *must* be furnished immediately on the prescribed blank to the car marker, who will mark the cars as provided in paragraph (a). When desired, any portion of the marks which will not be changed may be marked on the car before reweighing.
REASON—To compel railroad performing work to furnish immediate advice and not compel owner to await receipt of the billing repair card.
The Committee recommends that Section (g) of this rule be modified as follows:
(g) When a car is remarked the car owner *must* be notified of the old and the new weights, with place and date. The proper officer to whom these reports should be made will be designated in "The Official Railway Equipment Register."
REASON—To compel railroad performing work to furnish immediate advice and not compel owner to await receipt of the billing repair card.

Rule 32

The Committee recommends that answer to Interpretation No. 4 be modified as follows:
Q.—Does a car damaged by wreck, derailment cornering, sideswiping or other unfair usage, as defined under this rule, carry the same responsibility to any other car in the same train or draft, or to cars to which the draft is being coupled, if said other car develops, at the same time, only minor defects?
A.—Yes, *except as provided in Rule 33.*
REASON—To clarify the rule.
The Committee recommends an additional interpretation to this rule, as follows:
(11) Q.—Please define Item 5, Section (d), Rule 32.
A.—This provision is intended to apply to damage to the first car when caused by engine coupling on and includes additional damage to adjacent cars in same draft.
REASON—To clarify the rule.

Mr. Elliott: I asked that question yesterday and the committee would not answer it.

Dome covers and safety valves were added to the rule two years ago, if I remember correctly, and it is not the amount of them that is lost that warrants very much discussion. I do not think there are many, but I just wondered who would take a chance on the life of a man getting up at night on the top of the car to see if it was there. I just wondered why that was in the rule, and if they realized the danger of inspecting the car to find out whether those things are there or not.

Mr. Trapnell: I do not think there is any danger if you properly equip your man for inspection of that kind of commodities. If you will furnish the man with a flashlight or with these electric lanterns that they have in oil firms, I do not think you would have any trouble.

Mr. Smith: I think the framer of that rule had in mind when he made the rule that it would compel the railroad on whose line the cover became loose to see that it was put on. In other words, the cover ought to be on when the car is unloaded. That is where it is usually removed. I think that was the intent of the rule.

Mr. Elliott: Yes; but the trouble is you take records when you make inspections to protect yourselves between lines. How is a man going to know that the dome cover is up there at night if he does not get up there? Not one per cent of the roads in the country provide flashlights. We tell a man to stay away from the top of the tank car and here we put something in the rules that virtually tells him he must go up there.

Mr. Smith: I think there will be less missing dome covers with the rule there than there would be without it.

Mr. O'Donnell: If we are going to pass Rule 32 I am going to appeal to the members here morally to uphold this rule. A lot of people are inclined to make it a laughing stock. I really think to expedite the freight movement throughout the country it is the very best we can have and our Arbitration Committee and our officials want us to work that rule honestly and justly. Why should we get picayune methods in there and try to get a few dollars on technicalities that do not belong to us? We should be big enough and broad enough to run our terminals so that any man found wanting in working out Rule 32, be he yard master, superintendent or anybody else, will be corrected. I think it will do our association good to show that we take such a stand.

C. M. Hitch (B. & O.): In connection with Rule 32, I do not believe we go far enough in advertising through our transportation department, particularly yard forces and trainmen, the contents of Rule 32, to enable them to qualify in getting information relative to damages. I have recently furnished our yard foremen, yard masters, etc., a copy of Rule 32, requesting that, when damages occur caused by any of those items mentioned, they report accordingly and I am getting some results.

I. E. Guthrie (N. Y., N. H. & H.): Rule 32 on page 64 of the present rule book states: "No rider protection when necessary, if car is damaged to the extent shown in footnote to Rule 43, it is an owner's defect." I would like to have that interpreted here.

Chairman Westall: I think that is the understanding.

Mr. Cheadle: Mr. O'Donnell expressed my views when he said the tank company has offered all the protection that they can on these different parts; that is the cover and the cap; but yesterday the committee in answering a question as to whether caps are cardable in interchange said that this defect is cardable. Afterwards my attention was called to the fact that that portion of the outlet belt is not chained or tied in any way so that it would not become loose. It seems to me the railroad ought not to be responsible for the loss of a nut or plug used there.

Mr. Trapnell: If I remember, the committee on handling the nipple proposition on the bottom of the outlet cap reported that that would not be cardable.

Chairman Westall: Delivering line.

Mr. Trapnell: I do not see how you can make it the delivering line, because it is not the cap. It is only part of the cap.

Mr. Elliott: We went along for years in an unsatisfactory manner and we got to the point where we had joint inspections to certify whether the defects are new or old, etc. Rule 32 takes the opinion away from the car men altogether. You have nothing to say. It is the switchmen in the yard. The carmen have nothing to do about it now.

A. G. Hill (F. W. & D. C.): The protection given the tank car people for the missing dome covers, safety valve and outside cap is a good big item in our territory. We have a great many refiners on our line and sometimes the requested defect cards are for missing dome covers, etc. It runs into two and three hundred dollars a month from refineries where there are inspectors maintained. It is a big item for the tank car man.

Rule 33

Mr. O'Donnell: May I ask a question on Rule 33, while we are in that vicinity? Are repairs to safety appliances chargable to car owner on car derailed, cornered, sideswiped or subjected to any other Rule 32 condition where there is no other delivering line damage on the car, it being understood that damage to running boards on tank cars due to sideswiping and cornering is never chargeable to owner? Should they go to the owner?

Mr. Trapnell: Yes, sir.

Rule 36

Mr. O'Donnell: When you are removing the placards from tank cars, is it necessary that you cut the car in and delay it and wash it with hot water, or can we use the in-

spector's hook and take off the word "inflammable," and get most of it off, and call that a removal?

Secretary Sternberg: I would say not. You must get them off entirely.

Mr. O'Donnell: You are going to delay a lot of cars.

Mr. Trapnell: I think at our last meeting, Mr. Fitzgerald went on record as stating that five defect cards were issued for the removal of one placard from one tank car. If you are getting paid for it, do it the way you should.

Mr. O'Donnell: Mr. Aishton says every additional mile the car makes means a hundred thousand cars a month. Now, are we co-operating broadmindedly in that work or are we simply saying "that is none of our business"? I claim when you take the major portion of the reading off, nobody kicks. Am I right?

Secretary Sternberg: I cannot agree: I think the A. R. A. has made the rule for us to work by and they say nothing about delay to the cars. If we do not remove that placard in the proper way or obliterate it so it does not show, we must issue a defect card for it.

F. C. Schultz: If you expect to get paid for this work, you must remove the placards for the reason already explained, and I think the interpretation says you can't paint them over.

J. E. Vittum: I think we have never had a case where they were painted over, and it is our practice at Columbus to remove them entirely.

Rule 43

The Committee recommends that the note to this rule be modified as follows:

PROPOSED FORM—Note.—The handling line must furnish statement showing the circumstances under which the following damage occurred, if it is claimed the damage was result of ordinary handling. This statement, in the case of cars reported under Rule 120, to accompany request for disposition of car, and in cases where it is not necessary to report car under Rule 120, to accompany the bill for repairs:

(1) Six or more longitudinal sills on wooden underframe cars.
(2) Five or more longitudinal sills on composite wooden and steel underframe cars.
(3) Four or more steel longitudinal sills on steel or steel underframe cars.
(4) All longitudinal sills on all-steel underframe cars having but one steel center member.
(5) Two steel center members on tank cars having two steel longitudinal sills only.
(6) Steel tanks of tank cars shifted where secured by bolster or center anchorage.

REASON—The statement referred to should be furnished for steel underframe cars having one steel center member and for steel tanks of tank cars shifted where secured by bolster or center anchorage.

The Committee recommends an additional interpretation to this rule, as follows:

(2) Q.—Is damage to tanks of tank cars, caused by internal pressure of liquid, owner's responsibility?

A.—Yes, provided car was not damaged under any of the provisions of Rule 32.

REASON—To clarify the rule.

Mr. Elliott: On shifting tank cars, we have a number of cases, I think, where that should have been clarified, where the cars meet the A. R. A. specification of rivet shearing area. I had occasion a few years ago to check up a tank and found that the tank did not have sufficient rivet shearing area. I went into it then and checked a number of other cars and found there were a number of tank cars that did not have sufficient rivet shearing area. I suppose we are not making recommendations here, but I think that should be interpreted in that rule, because I am satisfied they do not want to penalize a handling line where the car is not properly built in the first place. At the proper time that could be taken up, and I suppose in the meantime if we had a case we could refer it to the A. R. A. Arbitration Committee.

Mr. O'Donnell: I would like to know what they mean by "internal pressure"; whether it is the swash of the liquid or internal pressure, or pressure on that basis.

Chairman Westall: I took that as the pressure of the liquid, but Mr. Chapman seemed to think differently.

Mr. O'Donnell: Well, it is a question we have got to pass on. We have got two cases where the end of the tank has been torn out, due to surge of the liquid.

Mr. Trapnell: I take it that this internal pressure means where they handle a car and do not give it proper ventilation and it soaks or sifts down at the bottom. We have had a couple of cases like that, where there was no evidence of derailment, no evidence of cornering, no evidence of anything falling on the car, but that was the condition as we found it, and we so passed on it, and made the owner responsible.

Mr. O'Donnell: Did he accept it?

Mr. Trapnell: He did.

Mr. O'Donnell: This tank I have in mind gave way right at the top of the shoe, where the shoe was riveted; went right across the shoe and then went up two feet. Now, we lost about 5,000 gallons out of 6,500. The bill for that was held. Now, that was caused by ordinary surging in the tank, I suppose.

Mr. Herbster: We have had two cases where the end of the tank came out without any fracture visible at the circle.

Mr. Trapnell: Only on the inside?

Mr. Herbster: Not on the inside. One case happened in the stock yards and there was not anybody able to see what caused it, and there was no evidence of Rule 32 conditions. The owner naturally thought that the handling line was responsible. It is my opinion that where internal pressure is exerted, either by vapor or swashing, the handling line is responsible.

Mr. Trapnell: I would like to ask Mr. Herbster what the safety valves on those tanks are for.

Mr. Herbster: The safety valves on those cars were not operating.

Mr. Trapnell: You don't get any pressure on that tank sufficient to take out the head.

Mr. Herbster: The head was out.

Mr. Trapnell: Did you go inside the tank?

Mr. Herbster: Yes, sir.

Mr. Trapnell: And did you steam it out?

Mr. Herbster: No, we did not.

Mr. Trapnell: Then you didn't go inside to find out whether there was a fracture in there or not.

Mr. Herbster: In one case we washed the fractured part of the tank with gasoline in order to determine whether there was a fracture or not, but did not find it.

Secretary Sternberg: It appears to me that if a tank is up to specifications any internal pressure that would force the end out would be an owner's responsibility, according to this rule. I think that settles the thing thoroughly.

Rule 60

The Committee recommends the following interpretation to this rule:

(4) Q.—In case air brakes are cleaned within nine months from date of last previous cleaning, may owner be billed for the work?

A.—Yes, when either triple valve or brake cylinder is found defective, unless air brakes are cleaned more than once on same road within sixty days from date of initial cleaning, in which case charge for subsequent cleaning is not permissible, regardless of whether previous cleaning was charged.

(5) Q.—In view of air brake stenciling on reservoir of tank cars being obliterated by slopping over of oil or other contents, is there any objection to relocating this stenciling on reservoir side of center sill at center of car on such tank cars as have only two longitudinal sills?

A.—On tank cars of this type there is no objection to this practice.

(6) Q.—Is it permissible to render bill for cleaning air brakes where air test is not given to the individual car, in accordance with standard instructions for annual repairs to air brakes on freight cars, after repairs?

A.—No, each car must be tested separately.

REASON—To clarify the rule.

Mr. Cheadle: We find cases of cars being returned where we have every reason to know that the stenciling on the cylinder is the clean date, but that the stenciling on the opposite side of the car is old. The men who are doing the work do not think to look all over the car to find it, yet the evidence is there and they come back and ask for recharging authority. There is nothing else to do under the rule but give it to them.

Mr. Owen: We recently had a case of air brake cleaning in 1924, and two months after that the owning line came back with joint evidence that the old stencil marks dated 1918 and 1921 were not properly obliterated. I traced the car and found that the air brakes had been cleaned four

different times and those old stencils not painted off, which were on the inside of the cylinder, on what you term the right hand side. I was under the impression that the joint evidence was final and that we would have to issue our counter billing authority, but I traced the car and found that since 1921 it had moved off and on the owning road forty-eight different times. They had not seen fit to correct or paint out that old stenciling from 1918 until 1924, one month after we had cleaned the air brakes. Instead of submitting the case to arbitration, it was withdrawn by the owner.

Mr. Fitzgerald: A number of railroads are not complying with the regulations in connection with stenciling the date of cleaning air brakes. Those roads that are putting more than one stencil on cars should issue instructions on their lines to eliminate the double stenciling.

Rule 68

The Committee recommends the following interpretation to this rule:

Q.—Is the delivering line responsible for a wheel slid flat and having worn flange, each defect exceeding condemning limit?

A.—Yes.

REASON—To clarify the rule.

Mr. O'Donnell: I want to ask a question on the length of the slid spot. If we have one wheel up to the limit of 2½ in. and the other one has slid only ¼ in. does the same responsibility exist? Do you scrap those two wheels?

Mr. Trapnell: I say, according to the law, we would.

Mr. O'Donnell: What do you do with that good wheel?

Mr. Trapnell: We remount it.

Mr. O'Donnell: You give cards right along on that basis?

Mr. Trapnell: There is no getting away from it.

Mr. Cheadle: I am familiar with the practice of a great many roads and I know there are one or two condemning the wheel and others that do not.

Mr. Trapnell: That is what I have been going to say, if you remove the wheel you would have to give the owner credit.

Mr. G. Lynch (Cleveland, O.): What disposition do you make of the wheel that is slid ½ in. and with a wheel that is slid 2½ in. or over? Also, how do you arrange in billing, if you appropriate the wheel for your own use? Do you give credit for it as a second-hand wheel or do you scrap it?

Secretary Sternberg: I would say yes, Mr. Lynch, if we get a defect card for two slid flat wheels, we would certainly scrap them both. If we only get a card for the one and not the other and it was fit for service, we would put it in the second-hand class and use it again.

Mr. Smith: I think this is another case where we all ought to be honest. I think the rule means that it is up to the receiving line to decide whether they are going to use that wheel again or not, and act accordingly. If the wheel has a ¼-in. slid flat spot, the chances are that we will use it again, and if we use it again, I don't think we ought to bill the party issuing the defect card.

Mr. O'Donnell: Should the chief inspector, in his conscience, give a card for two wheels? I think the evil should be stopped when it starts. If we examine those wheels and we find one wheel mated on that axle is just skimmed, I believe there should be a card on only one wheel. I think we ought to treat that money just the same as our own money. That is the reason I don't feel right in giving cards unless you know what you are going to do with that wheel. The average credit, prior to 1920, didn't matter. Second-hand and scrap were all on the same basis, but now there is a difference and you have got to consider it.

H. Andrew (N. Y. C.): From a mechanical standpoint, it is often absolutely impossible to find a wheel to mate with the ¼ in. slid flat wheel. Then again, the Arbitration Committee has provided in the remounting of second-hand wheels that certain conditions which prevail will condemn the wheel and make the delivering line responsible. Until the present rules, it has been impossible to re-bore cast iron wheels over and above the maximum bore which was specified under the rules. Now we are permitted to exceed that by 1/16 in. in order that it may be possible to remount second-hand wheels and put them into service. It rests with the mechanical department as to whether they can use the slid flat wheel, and have you any right to say, "this wheel is fit for service," when it cannot be remated or the bore is excessive? I think the joint inspector has no jurisdiction in this case.

Mr. O'Donnell: I would like to answer that question by asking: Why do the Arbitration Committee and the Master Car Builders' Association give us the right to force the receiving line to take wheels if they are within the 2½-in. limit? Those wheels are not condemnable. If we have a pair of wheels coming from one road to another, and the wheel is slid ¼ in., isn't it just as bad to put that wheel in the shop and call it scrap? I want to know whether we are going to dip our hands in the delivering line's treasury. I claim there should be in the billing department a tacit understanding that if you get a car having a pair of slid wheels, if two of those wheels are good, you should allow proper credit to the delivering line.

Mr. Cheadle: May I ask why all this discussion? Why not have a recommendation as Mr. O'Donnell says? Inasmuch as the rules are plain, let us live up to the rules. Let the mate wheel carry the same responsibility.

Rule 70

The Committee recommends that the first two paragraphs of this rule be modified as follows:

PROPOSED FORM—Delivering company responsible.

Cars stenciled "wrought-steel wheels," if found with cast-iron, cast-steel, or steel-tired wheels.

Cars stenciled "cast-steel wheels," if found with cast-iron or steel-tired wheels.

REASON—The status of the steel-tired wheel is not such as to require the protection of this rule.

Mr. Cheadle: I would like to ask about the stenciling of the car. In a great many cases, where cars on certain railroads are known to inspectors, the steel wheel is standard to them, and they don't wish to call for joint evidence because they know and can see a portion of the stenciling left on the car, but in the last 12 months I have observed many cars on which a man who was not familiar with that series of cars could not tell whether the car was stenciled "wrought-steel wheels" or not. It certainly puts the intermediate line, or the second intermediate line in for an unjust responsibility. I know of one case where the only remaining indication on the car that it was stenciled "wrought-steel" was where it had the small end of the letter "T" stamped on it. The man saw the end of the "T" and gave a defect card, and yet that line was in no way responsible for the car. I want to mention that because those who are familiar with the construction of the car ought to go further in maintaining the stenciling. It has given a lot of trouble on my end of the road.

Mr. Trapnell: I will agree with Mr. Cheadle that we have many cars running over the country that you can't get the number and initial of. And yet here is a man who receives a car at night, in the small hours. He has a small lantern, and in looking over the car cannot find any stenciling on it, but his line is penalized because he does not find something that was stenciled on the car. I contend that, being the delivering line's responsibility, it should absolutely be placed in joint evidence, so the man who committed the crime will be the one penalized.

Rule 93

The Committee recommends that the second paragraph of this rule be modified as follows:

PROPOSED FORM.—All charges for repairs made to cars on account of owner's defects, defect cards and rebuttal authorities shall be consolidated against any one company into one bill.

REASON—Balance of rule is out of date.

N. M. Pyle (S. P. R.): All charges for repairs made to

cars on account of owner's defects, defect cards and rebuttal authorities shall be consolidated against any one company into one bill. I try, in rendering bills, to live up to the instructions given by the different roads in the equipment register and the rules. I have in mind at the present time a bill rendered against a railroad applying door protection on authority of a transfer card as issued. Now, in rendering that bill, I referred to the equipment register. There is nothing in there that says that bills of that nature shall be rendered separate from car repair bills, so I included that bill. It is a transportation bill, but still it is an operating expense, and I included this amount in my regular car repair bill. Now, the road I billed for this is requesting that I eliminate from the car repair bill that amount and render a separate bill. I would like to know what the practice of others is in order that I may correct my practice if I am wrong.

Secretary Sternberg: I think you will have to separate it because the transportation bill cannot be included with car bills.

Mr. O'Donnell: All those bills are made separate upon the A. R. A. bills in our district.

Chairman Westall: We have finished the freight rules and all that is left, I believe, is the passenger rules.

Mr. Trapnell: I think that the passenger changes are only in conformity with the freight rules to bring them up to date and that can easily be handled by each individual. As it will not require any discussion, I move you that the rules stand approved as we have had them so far, including the passenger rules, to save the reading.

(The motion was seconded and carried.)

Additional Business of the Association

The members voted to give more time to the discussion of A. R. A. rules of interchange, repair, billing and loading as this is the primary function of the Chief Interchange Car Inspectors' & Car Foremen's Association. On motion of Mr. Trapnell, the association voted to devote the entire second day of next year's convention to the consideration of these subjects.

Amendments to the constitution were adopted to provide for a third vice-president. The retiring president will become chairman of the executive committee to consist of seven elective members and the past presidents. The term of office will be one year except for the executive committee, in which case the term will be two years. The dues of active and associate members of the association were made $3 a year payable in advance and the secretary's salary was increased to $300 a year.

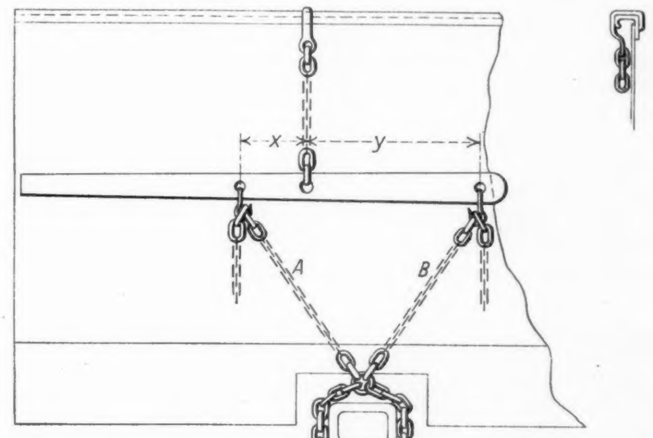
Prizes for securing the largest number of new members during the year were awarded to E. R. Campbell, general car foreman, Minneapolis Transfer Railroad, Minneapolis, Minn., who secured 80 new members; W. R. Rogers, chief interchange inspector, all roads, Youngstown, Ohio; B. F. Jamison, special traveling auditor, Southern, Meridan, Miss., and H. J. Budd, Boston & Maine. The prize consisted in each case of a card which entitles the recipient to a copy of the 1925 edition of the Car Builders' Cyclopedia which is now under preparation and the first copies of which will probably be received from the printer early in January of next year.

For the association Mr. O'Donnell, chairman of the committee on resolutions, extended thanks to R. H. Aishton, Charles Dillon and W. F. Brazier, for addressing the convention; also to President Westall and Secretary Sternberg for the effective way in which they conducted the affairs of the association during the year. A vote of thanks was extended to W. T. Walsh, president of the Supply Men's Association, for the exhibition and entertainment provided. The 1924 convention was then closed with prayer by Mr. Jamison.

Hoisting Lever for Applying Couplers

ONE of the most common jobs with which a carman assigned to an outlying car repair point has to contend is that of repairing or replacing broken couplers, coupler yokes and draft gears. The most difficult part of the job is raising the coupler into position for application. By the use of the lever hoisting device shown in the sketch, one man can easily lift a coupler, with the yoke attached, to its place between the draft sills on the car.

This device is easy to construct and operate. The lever is fulcrumed to a chain which is hooked over the end of the car and two chains, *A* and *B* are secured to the lever and coupler shank as shown in the sketch. The lever hook for the chain *A* is located a shorter distance *X* from the fulcrum on the



Sketch Showing a Hoisting Lever by Which One Man Can Raise a Coupler into Position

lever than the hook for the chain *B*, which is located at a greater distance *Y*. The distance *Y* must be considerably greater than *X* to give the operator a greater leverage and hoisting distance for each movement of the lever. To operate the hoist the repairman stands on the end sill of the car and pushes down on the lever handle. This movement causes the chain, *A*, to be slacked and the entire weight of the coupler is carried on the chain, *B*. The slack of the chain, *A*, is then taken up and the weight is transferred from the chain *B* by slightly raising the lever handle. The slack is then taken up in the chain, *B*, and the operation is repeated until the coupler has been raised to the desired position.

Interior View of the Angus Steel Car Shops of the Canadian Pacific, Montreal, Que.

Safety Work in the Car Department

Duluth, Missabe & Northern Works 2,412,800 Man-Hours with Single Accident

By W. A. Clark
General Car Foreman, Duluth, Missabe & Northern, Proctor, Minn.

This article is an abstract of an address by Mr. Clark at the thirteenth annual congress of the National Safety Council held at Louisville, Ky., October 1, 2 and 3. The safety measures outlined in the article are particularly significant and valuable because they work. From October 16, 1921, to September 1, 1924, when the address was prepared, the car department of the Duluth, Missabe & Northern had only one accident disabling an employee for more than one day. In other words, a period of 34 months elapsed with but a single accident and during this time 2,412,800 man-hours of work were performed. Mr. Clark generously gives credit for this splendid performance "to the management which provided every facility to make conditions safe, to the safety department under the direction of A. V. Rohweder, which labored continuously to instill the safety spirit and to each and every supervisor and safety committee member of our department."—EDITOR.

GENERAL car shop work in the nature of repairs both heavy and light presents unlimited possibilities for injuries. The operation of each shop will have problems of its own: the shop served with cranes and where jacks are not used; the shop that is without cranes and where jacks are used; points where inspection and repairs are made to equipment in yards and terminals.

The supervisors in charge of new work or the rebuilding of cars must be ever alert to see that the maximum admissible floor space is kept free from stumbling, falling, and tripping hazards; that material is safely piled, and that proper and necessary scaffolding is provided; that goggles are furnished and worn when drilling, reaming, chipping, and riveting is being done; that riveters and helpers have a tight band or handkerchiefs around their necks to protect their backs and gauntlets or tight sleeves to prevent hot rivets from going up their sleeves.

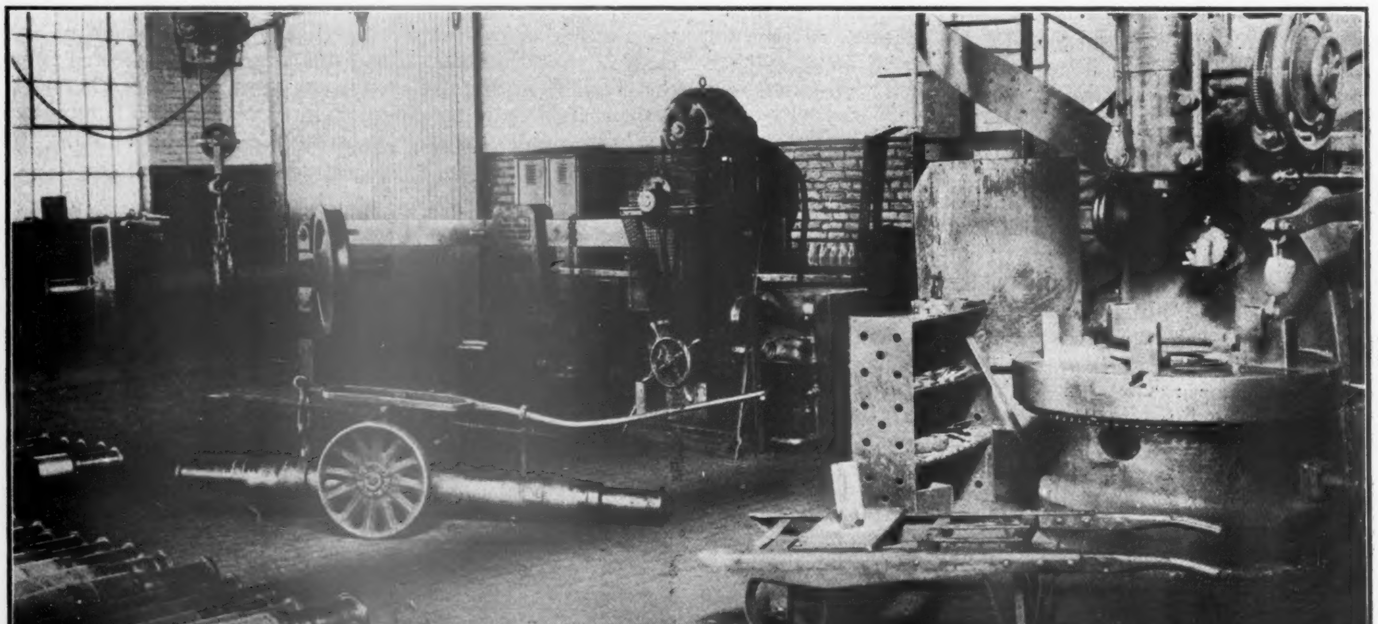
In handling structural steel and plates with cranes, safety hooks should be used. One man only should give signals to the crane operator, and when cars are moved to new positions by cables or cranes, operators should be instructed not to take signals to start or move a crane or car along the tracks until some competent person is stationed at the end of the car in the direction it is to be moved, to make sure that no one is in the way, or that no men are underneath, between, or in the hopper openings.

Trestles, horses and scaffolding should be standardized, regularly inspected and kept in a safe condition. All ladders should have safety ends and all scaffold planking have a bolt running through each end to prevent splitting. On each end of scaffold planking cleats should be nailed to prevent planks from slipping off the ends of trestles.

Absolute confidence should not be placed in the reliability of jacks. Horses should be used as an auxiliary in all cases where men have to go under car bodies. Also an absolute rule should be made that no man be allowed to expose his body or limbs between trucks and frame of car until proper blocking is placed between the truck bolster and the car, or under the side bearings.

To prevent men from putting their hands on the inside of cranes hooks or taking hold of cables while lifting cars, a handle should be put on the hook on the opposite side from the point, and all concerned properly instructed in the safe method of handling hooks or cables.

The removal of stuck or wedged friction gears should be properly supervised. Inexperienced men should not be



A Corner of the D. M. & N. Wheel Shop at Proctor, Minn., Showing Safety Hook or Tongs for Handling Mounted Wheels, Axle Truck and Truck for Handling Unmounted Wheels

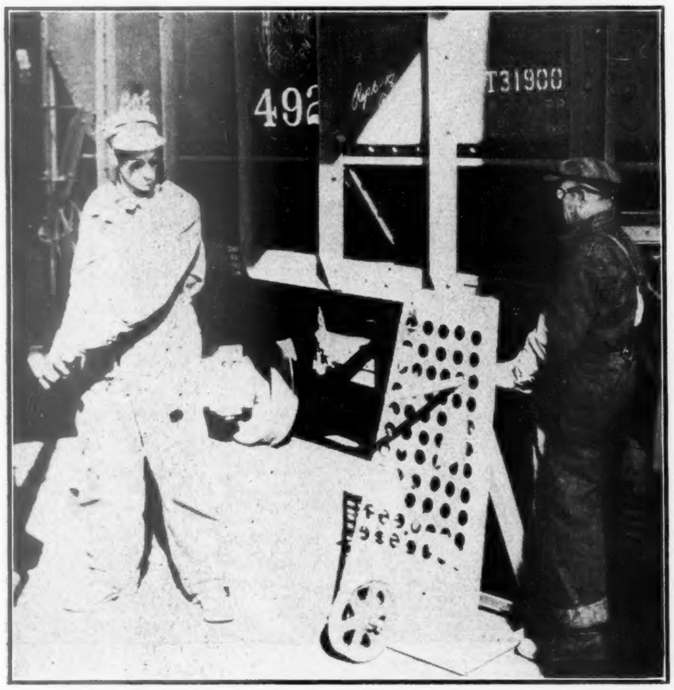
allowed to handle them. When removing supporting plates and couplers from cars, air jacks on trucks, or blocking should be used to prevent couplers and draft gears from falling to the floor when nuts are removed from carrier iron and supporting plate bolts.

Extra precaution and care must be used in blocking box car bodies to make them safe when trucks are removed on repair tracks not protected from winds. During high winds the number of trestles or horses should be doubled.

General Rules

No tools, car parts, knuckles or knuckle pins should be left on platforms, ends or tops of cars while cars are being repaired.

No passenger, baggage or caboose equipment should be sent to shops for repairs or men allowed to work on them until all torpedoes have been removed.



Chisel Bar Guard for Use in Cutting Rivets with Chisel and Sledge

Striking truck springs with hammers or sledges to drive them in place is dangerous. When necessary to do this a block or piece of wood should be used between springs and hammers.

An inflexible rule should prohibit the practice of men putting their hands on center pins to guide them in place while lowering car bodies on trucks. Also blocks should be used under all conditions of service that require men to expose their bodies or limbs, under any part of a car that may be raised or jacked up, or held up with a bar. This practice is the only one that will prevent crushing, and maiming should the parts move, slip or fall.

Car men should not be allowed to raise steel doors, bolsters or other parts with bars, and other men expose their hands or fingers until the part raised has been made safe by blocking securely. Then should the bar slip the man with his hand exposed will be safe.

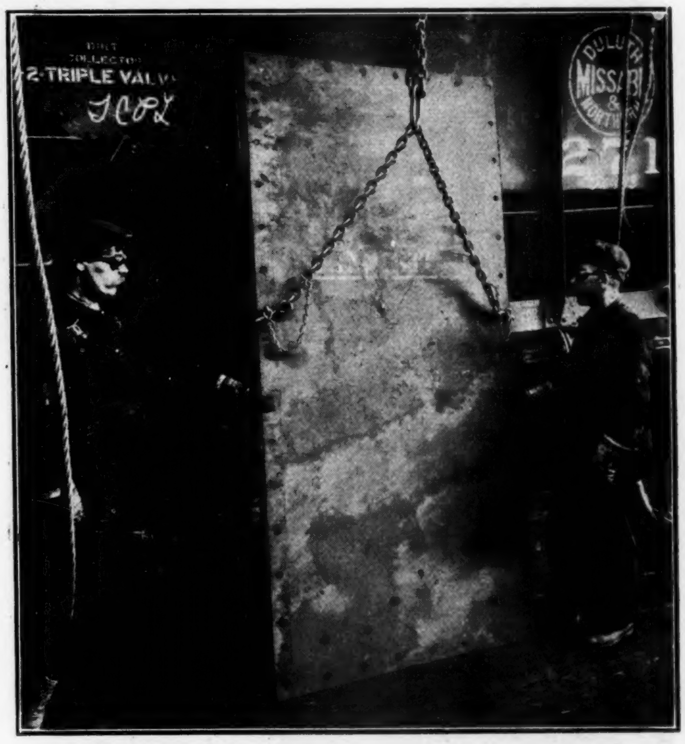
All tools should be inspected daily, defective ones removed from service and a place provided for tools that become defective or unsafe while being used. That is, a tool that has become defective should not be placed in the workman's tool box; it should be removed to a place designated for defective tools. Pneumatic hammers for car work should be fitted with inside triggers and safety retaining clips. Air hose and fittings should be inspected weekly for loose clamps and soft inside linings. The use of oil should be prohibited in the mounting and the repairing of air hose fittings.

Acetylene and oxygen gas lines and fittings should be inspected and back pressure valves filled daily if necessary. All defective gages, regulators and torches should be removed from service and returned to the maker or company making repairs. The mounting or fitting of gas hose should be done by or under the supervision of a competent welder. No one should be allowed to use the acetylene outfits until they have been thoroughly instructed in the use of regulators, gages, and torches; in the danger from oil coming in contact with oxygen gas; and the safe handling of gas tanks under pressure, and passed on as being competent by a regulator instructor.

Cutters and welders should be chosen with due regard to ability and fitness for such work, and thoroughly instructed in the care necessary to handle gases under pressure and not allowed to work alone until their instructor is satisfied that they understand how the regulators, gages, and torches should be used without endangering themselves or their fellow workers.

Machine Shop

The handling of unmounted wheels is best done by the use of a truck designed to prevent wheels from over balancing or falling. The element of risk is ever present when rolling them on their flanges. Unmounted wheels should be piled and blocked to prevent them from falling or tipping forward. Axles should be stored in a manner that will keep them from slipping. Operators of such machines as the wheel borer, axle turner, bolt cutter and punch and shear must wear goggles while working on their machines. Lifts, hoists, cables, hooks, and slings should be kept in good condition.



Safety Hooks with Pins Permanently Attached for Use in Hanging Sheets in Place on Steel Cars

Wrenches, hammers, or any object falling from the throat or head and striking the tripping lever of punch and shear machines may result in a serious injury. Therefore, this particular lever should be covered or protected in a manner

to make the machine operative only when the lever is pressed by the foot of the operator.

Air Brake Work

While cleaning brake cylinders use a safety clamp around the piston sleeve with a ½-in. bolt. Placing a nail in the sleeve in place of a clamp, is not a sure method of preventing injuries.

When testing brakes, see that the cut-out cock is closed and pressure allowed to escape from the reservoir before making adjustments. This will prevent the workman from being struck by levers. Also use a key bar in the key hole to pull it in line, instead of attempting to do this with the fingers.

Air hose used for testing cars or trains should have a drain cock in the hose head to reduce the pressure before uncoupling and to prevent particles of dirt being blown in the workman's eyes.

Pipe wrenches should be maintained in a safe working condition to prevent them from slipping and injuring the operator.

Paint Shop, Blacksmith Shop and Wood Mill

In the paint shop, ladders, horses, scaffold plank, paint burners, benzine, gasoline, lye, caustic soda, and acids,

A Crane Hook with a Safety Handle

slipping and falling from ladders and roofs are the most prevalent causes of injuries to be guarded against.

In the blacksmith shop, burns from scale or handling hot iron, contusions from iron falling or being knocked from power hammer and when cut at anvils, and chips from the heads of battered tools are the principal causes of injuries.

Wood working machines in the wood mill should be rigidly guarded. Guards must be kept in condition and none but competent or experienced operators allowed to use the machines. Operators of wood working machines should be taught the proper position of their hands. A man trying to see what is going on in other parts of the shop will not make a safe wood mill employee.

Yards and Terminals

Inspectors light repair men, air men and oilers work in yards and terminals. It is necessary to see that these men are constantly reminded that switches must be locked or blue flags or lanterns used before going between or under cars. They must be taught to walk between tracks instead of between the rails while on duty, and when it is necessary to cross tracks stop and look in both directions. The practice of car men getting on or off moving trains should be prohibited.

Using a Broom When Backing Out a Rivet

Wrecking

Wrecking foreman should be thoroughly trained in safe practices. The necessity of using outriggers and clamps, preparing a safe foundation for the crane before taking a heavy lift, properly blocking the crane and having reliable men follow up and tighten the wedges and blocking wherever the strain or load is removed from the boom, should be stressed. An efficient lighting system for night work should be provided.

The practice of securely blocking overturned or leaning cars and engines, before men are sent underneath, keeping men clear of chains or cables while pulling or lifting, are a few of the things a wrecking master must do if he is to keep his crew safe from injuries.

Safety Enthusiasm Needed

After all details of mechanical safeguards have been perfected it will be apparent that the ideal or true spirit of safety must come from the supervisors. Success in safety work must start or emanate at the top. Enthusiasm for safety should radiate from the head of the department. Interest and success in safety work depends on the attitude of the supervisors.

The supervisory forces must plan and lay the foundation if they aspire to build a monument to safety. No supervisor or safety committee member should allow any unsafe prac-

tice to go unchecked. The duties and responsibilities of supervisors must reach farther than guarding the machinery and providing mechanical safety devices.

After this has been done the men or workmen must be educated to the point that they will guard themselves. All new men should be thoroughly instructed in the hazards of the work assigned to them. This should be done by the foreman hiring them and again by the foreman in charge of the department they are assigned to. As the individual becomes more careful the morale of the organization will improve. Obstacles in the road to accident prevention will have disappeared. The results will be a larger output and a better class of work.

Recent Decisions of the Arbitration Committee

(The Arbitration Committee of the A.R.A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Car Repairs Claimed and Not Made

The Terminal Railroad Association of St. Louis on May 10, 1921, rendered to the Mather Stock Car Company a bill amounting to $2,543.01, covering charges for repairs during the months of February and March, 1921, and also, a few repair items leading back to October, 1920. Exceptions were taken by the car owner to the number of charges rendered for knuckles, knuckle pins, knuckle locks, brake shoes and a few other items on the cars which were repaired during the months of February and March, 1921, in the stock yards, prior to sending the cars to the loading chutes. The Terminal Association in its statement pointed out that the work of conditioning stock cars passing over the repair tracks of the East St. Louis Junction Railroad at the National Stock Yards, was performed by an inspection and repair organization operated under the auspices of the Superintendents' Association of the St. Louis-East St. Louis terminal district. The repair and inspection work was formerly handled by car department men of the individual railroads handling stock or other shipments in or out of the yard. Without citing a specific instance of overcharge, the owner endeavored to prove that the cost of repairs made by the unified car department forces averaged, approximately, 84 per cent in excess of the same work done at its own or contract shops. This claim was based on the amount and the cost of work performed by the owner's repair men, established at the stock yards, during a period subsequent to May 21, 1921, the items of which were checked against the bill in question rendered by the T. R. R. A. The Mather Company suggested to the Terminal Association two different joint investigations, which the latter refused to make on the grounds that the repair car stubs could be checked with the original record. The owner objected to this, claiming that the original record was wrong as the repairmen wrote up these records and in order to make a good report, often indicated repairs that were not made. They also were expected to do a fixed minimum amount of repairs every day under the A. R. A. rules which the owner believed, accounted for the results shown.

The following decision was rendered by the Arbitration Committee: "There is no evidence presented that would show that these repairs were not made as billed. Decisions 1017, 1018, 1057, 1080, 1088, 1108, 1130 and 1233 apply."—*Case No. 1308, Terminal Railroad Association of St. Louis vs. Mather Stock Car Company.*

Responsibility for Car Destroyed by Fire

At 11:25 p. m., January 25, 1923, the Kansas City Terminal delivered a transfer of 16 cars to the Chicago & Alton's Twelfth Street yard at Kansas City, Mo. W. H. T. X. car No. 200, loaded with gasoline and leaking, was included in this transfer. Fifty minutes after this delivery had been effected, W. H. T. X. car No. 200 was discovered on fire and was destroyed. The Chicago & Alton refused to assume responsibility for the destroyed car on the grounds that the car was leaking when taken by the Kansas City Terminal from its Mill Street yard and was still leaking when placed on the interchange track or in the Chicago & Alton's yards. Rule 2, section B., paragraphs 1 and 2 of the A. R. A. rules was quoted, and also paragraph 1909 from the Interstate Commerce Commission regulations, which both indicated that whenever a tank car loaded with an inflammable liquid is discovered leaking in transit, all unnecessary movement of the car must cease until the unsafe condition of the car is remedied. The Kansas City Terminal based its claim on statements taken by Terminal and Alton officers from those employees who handled the car, which indicated that the car had not been leaking at the time it was pulled from the refinery and that it was handled fairly between this point and the Chicago & Alton's yard. Rule 6 of the by-laws and rules of the superintendents' association of Kansus City was also quoted to substantiate the statement that the car had been delivered to the Chicago & Alton.

The Arbitration Committee rendered the following decision: "It is admitted by the Kansas City Terminal that this tank car was leaking gasoline before offered in interchange and that they failed wholly to remedy this condition; the tank was still leaking when the car was moved by Kansas City Terminal to the Chicago & Alton lines, which movement was a violation of Paragraph 1043 of Interstate Commerce Commission regulations. There is no evidence that the car was accepted by the Chicago & Alton. Responsibility for damage to car, therefore, rests with the Kansas City Terminal."—*Case No. 1310, Chicago & Alton vs. Kansas City Terminal.*

Responsibility for Wrong Repairs

The New York, New Haven & Hartford on March 18, 1920, at its South Boston shops removed, repaired and replaced a brake shaft on A. T. & S. F. box car No. 25061. On May 24, 1921, at Richmond, Cal., the A. T. & S. F. obtained joint evidence in accordance with Rule 12, showing one brake shaft 1¼-in. by 12-ft. 2-in. instead of one brake shaft 1¼-in. by 12-ft. 7¼-in. and made standard repairs at the same point June 4, 1921. In accordance with Rules 12 and 13, joint evidence and the billing repair card were forwarded to the New York, New Haven & Hartford and a defect card requested to cover the wrong repairs which it perpetuated. The repairing line refused protection, contending that it was not in position to know what length of brake shaft was standard to the car.

The Arbitration Committee rendered a decision to the effect that while the A.R.A. Standards mention no minimum length of brake staff above the ratchet wheel other than the required clearance around the brake wheel, the car owner must be protected against deviation from its own standard length. Providing the New York, New Haven & Hartford had straightened and replaced the same brake staff that was removed it is not responsible for the wrong repairs. If another one was substituted or alteration made in the length of the brake staff removed and replaced it is responsible for wrong repairs.

This decision supersedes the decision in case No. 695 to this extent.—*Case No.* 1313, *Atchison, Topeka & Santa Fe vs. New York, New Haven & Hartford.*

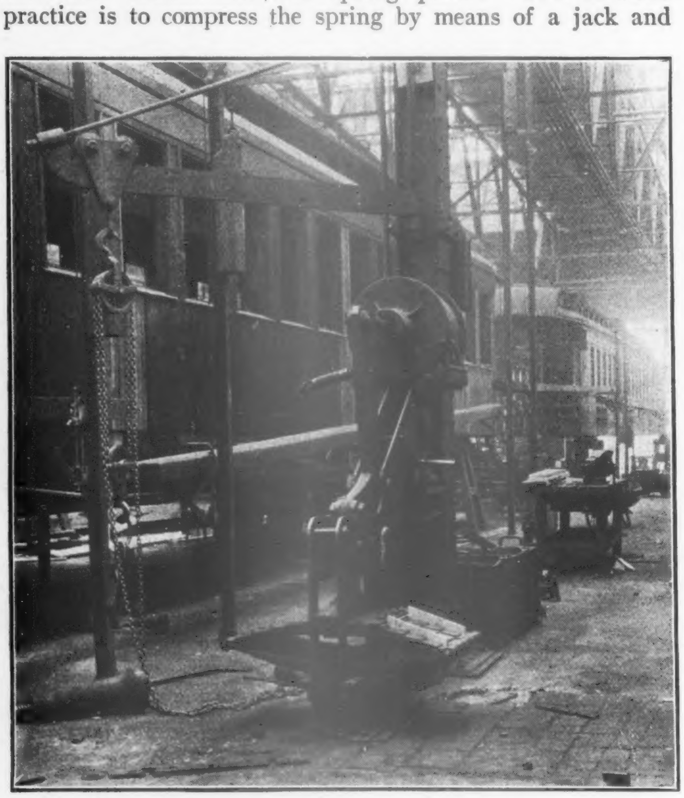
Responsibility for Car Damaged in Switching

On October 20, 1922, while switching over the hump track at Manheim, Ill., on the lines of the Chicago, Milwaukee & St. Paul, two cars containing scrap iron and in charge of a rider, were sent down on track 29 and came in contact with Chicago, Indianapolis & Louisville flat car No. 13324 loaded with stone, damaging the latter car. The handling line contended that the car was not subjected to any of the unfair usage conditions enumerated under Rule 32; that rider protection was furnished and that everything possible was done to prevent damage. It, therefore, reported the car to the owner for disposition under Rule 120. The car owner took the position that the car received unfair usage in that the speed of the cars which came in contact with the damaged car was excessive, and that the case should be handled under Rule 112.

The Arbitration Committee, in a decision rendered February 15, 1924, sustained the contention of the Chicago, Milwaukee & St. Paul and referred to the decision in case No. 1239 as being applicable to this case.—*Case No.* 1312, *Chicago, Milwaukee & St. Paul vs. Chicago, Indianapolis & Louisville.*

Machine for Clamping Elliptic Car Springs

ONE of the troublesome jobs in repairing passenger car trucks is the replacing of the elliptic springs between the truck bolster and the spring plank. The common practice is to compress the spring by means of a jack and



Air Operated Machine for Compressing Elliptic Springs for Clamping Before Applying Them to the Trucks

then clamp it in this position. This method requires considerable time and hard work. In order to perform this job with a minimum amount of time and labor, a machine has been developed at the North Billerica shops of the Boston & Maine for compressing the springs so that they can be readily clamped.

As shown in the illustration, the machine is fastened to one of the steel columns of the building. A 16-in. car brake cylinder furnishes the power which is transmitted to the spring by a bell-crank, the arms of which have a ratio of 3 to 1. The air is controlled by a two-way valve.

The springs are placed under the machine by a swinging jib crane to which is fastened a chain hoist. The spring is then compressed and clamped by two four-bolt clamps, one on each side of the spring bands. The spring is then taken from the machine and can now readily be placed between the truck bolster and spring plank. When replacing a set of elliptic springs on a truck, it is claimed that clamping the springs with the aid of this machine has reduced the working time by 30 min.

Links for Coupling Wreck Crane Cables

IT is often necessary when clearing up wrecks to couple two cables together or to couple the end of a cable to a car. Figs. 1 and 2 show a coupler cable link and a cable link which are being used for such service. Both of these

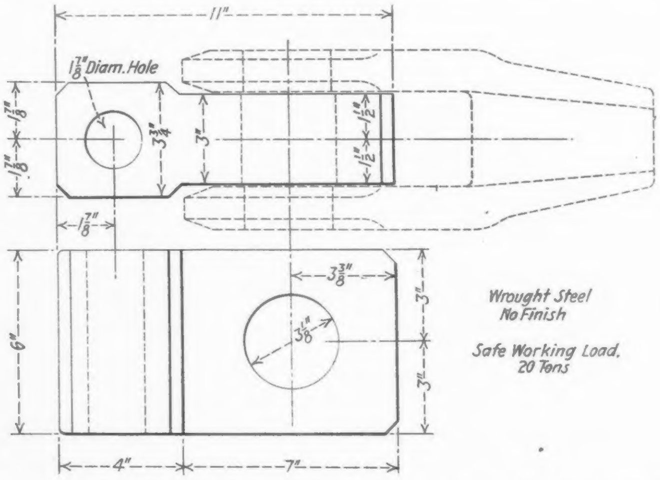


Fig. 1—Drawing of Link for Attaching a Cable to the Coupler of a Car

links are made of wrought steel and can be hammered out in the blacksmith shop. The coupler cable link is designed for a safe working load of 20 tons, and the cable link is

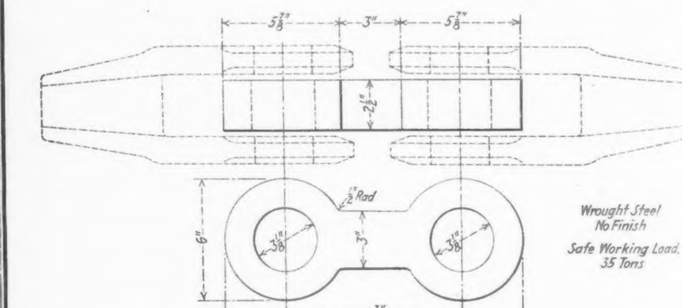


Fig. 2—Drawing of Link for Coupling Cables

designed for a safe working load of 35 tons. The method of securing these links to the cable sockets is shown in the drawings. The coupler cable link is secured to the coupler by removing the knuckle and holding the link in place with the knuckle pin.

The Prevention of Hot Boxes on Freight Cars*

Thorough Inspection, Analysis of Causes and Periodical Repacking Prevents Trouble

By E. Von Bergen
Air Brake and Lubricating Engineer, Illinois Central

THE problem of combating hot boxes on freight cars, is probably as old as the railroads. It is a problem that is of especial interest to the car foreman, in that he is the man who is held particularly responsible for their prevention and receives the largest measure of criticism for their occurrence.

In presenting this paper an attempt will be made to deal in a practical manner with the facts and conditions that confront us on the railroads today.

From the studies I have made while engaged in supervising the lubrication of locomotives and cars during the past few years, it seems to me that the pendulum of freight car lubrication swings from one extreme to the other. Years ago, economy in the use of oil was given no consideration whatever. In later years the oil companies made contracts with the railroad companies for furnishing the lubricants for their equipment, either on a gallonage basis, or a guaranteed mileage basis and seeing the terrific waste that was prevalent, agreed to furnish lubrication engineers who would instruct the men in proper practices. For many years it was dinned into the ears of the men how little oil was required to lubricate a journal, and it is a fact that it requires an astonishingly small amount. But the pendulum then swung to the other extreme and it would seem that many men who look after the lubrication of freight cars are under the impression that once the boxes are packed the car can run for years without any further attention. It is presumed that every freight car has the journal box packing removed and the boxes repacked approximately once every 12 months. If you have never done so, it would be very interesting to make a check of all the cars standing in any yard and observe from the packing stencilled record how much time has elapsed since the boxes were repacked.

In order to reduce to a minimum the hot boxes on any railroad, it is necessary to provide reports of such nature, that those in charge are advised from month to month as to the number of hot boxes developing on cars dispatched from each terminal.

Nearly every road issued a monthly report showing the number of car miles run per hot box on each division, but while this report shows any decrease or increase in the number of hot boxes in proportion to car miles made on each division, it does not provide information as to the performance of terminals. Neither does a report showing the number of hot boxes developing on cars forwarded from any particular terminal reflect the true situation. Therefore, to be properly informed, a report should be compiled at the close of each month which will show:

Name of terminal; number of cars forwarded; number of cars set out on account of hot boxes; number of hot boxes repacked by trainmen enroute and taken to next terminal; total hot boxes; number of cars forwarded per hot box. This report may be separated as between system and foreign cars if desired.

I have found this report, taken in connection with that showing miles run per hot box, invaluable in immediately reflecting terminals whose performance in prevention of hot boxes was not what it should be and requiring action to bring about an improvement.

Proper Repacking Important

The first essential in the prevention of hot boxes is, of course, to properly repack them after the packing has been removed for any reason. As to the proper method, opinions differ somewhat. All agree that a back roll, either made in the packing room or by the box packer, should be placed firmly in the back end of the box to exclude dust and retain oil. From there on, the process of packing may be divided between two general methods, one of which is to place one mass of packing under the journal extending half way up on either side and omit the use of the front plug. The other, is to place sections of packing under the journal extending half way up on either side, continuing this until the collar is reached, the last section to be tucked behind the collar presenting a perpendicular wall extending from the inner edge of the collar to the bottom of the box, then placing a wedge of packing between this wall and the front of the box, the top of this wedge, or plug, extending only one-half inch above the bottom of the collar and no threads of waste from this plug being permitted to interlace with those in the packing beneath the journal.

Of the two methods, I unhesitatingly recommend the latter, as I have tested out both and while with the former, the packing soon works out of position and requires frequent re-adjustment, I have seen the latter run hundreds and even thousands of miles without materially changing position.

In combating hot boxes on freight cars, there are but three different policies that can be pursued, viz.:

First—Oiling all boxes with free oil at terminal yards.

Second—Thorough inspection of the packing in all boxes at terminals and removing and re-adjusting the packing in all those found in improper position.

Third—Pulling and repacking all boxes on all cars while on repair tracks, regardless of the stencilled date showing previous repacking.

I shall not attempt to say which policy your road should pursue, but I will point out as briefly as possible, the scientific method by which you may arrive at a conclusion and it then remains for you to make your recommendations to your management as to which method you determine is the most efficient and economical.

Three Methods of Combating Hot Boxes

Oiling All Boxes With Free Oil At Terminals—This is the easiest and quickest method and entails the lowest labor cost, but it is the least effective, due to the fact that with packing improperly adjusted, surplus oil cannot and will not prevent all or even a very substantial number of hot boxes. It would prevent many that occur from dry packing.

Thorough inspection of the packing in all boxes at terminal yards and removing and re-adjusting the packing in all those found in improper position—Thorough inspection of the packing does not mean raising the lids and looking in the box. It means inserting a slender packing hook to the extreme back end of the box to determine whether the pack-

* A paper presented at the September meeting of the Car Foremen's Association of Chicago, and also at the convention of the Chief Interchange Car Inspectors' and Car Foremen's Association.

ing at the back end has settled away from the journal and in many cases before the hook can be thus inserted, packing has to be pulled out from the side of the journal as some one has filled it nearly to the brass, or it was improperly packed and crawled up. Re-adjusting the packing does not mean jabbing the packing in the front of the box with the packing knife, it means removing at least one-half the packing, pushing the remainder to the back end, then returning the removed half to proper position, as previously explained in the second method. To attempt to push the entire mass of packing back is worse than useless, as it merely jams the packing about half way back and makes bad matters worse. To ascertain in a few minutes whether inspection and re-adjustment in the terminal yards under your jurisdiction is being done as above described, calculate as follows: It is necessary to allot an average of two minutes per box and I may say in passing that every man on your force will have to hustle on this allotment. Take the average number of cars that pass through the terminal yard each 24 hours and multiply by eight which shows the number of boxes requiring attention; then multiply this figure by two and you have the number of minutes required. Now take the number of man-hours in each 24-hour period you have at your disposal for attending to journal boxes. Multiply these hours by 60, and the result should equal the minutes required. If any of you have a sufficient number of men engaged to meet the figures I have given above, or even half the number, I wish you would write me and tell me where the terminal is located, as I should like very much to visit it. Some of you are now thinking. "It is not necessary to test the packing with the hook, a competent man can tell when a box is properly packed by looking in it." To those of you who think this, I would say, "Stop fooling yourselves." If the packing has badly bulged in front, it, of course, indicates that it has "corkscrewed" out from under the back end of the journal, or was packed too full in the first place. If a dry spot appears on the end of the journal, it indicates it has been running above normal temperature. But, I have inspected hundreds of boxes and I have found scores which the inspectors or oilers pronounced all right, and to which I agreed looked to be properly packed, but when we inserted the hook to make sure, we found a hole below the journal at the back end of the box. Such a box is a potential hot box when it leaves a terminal. The packing may look right and may be right, but the only way to be certain that it is right is to test it with the hook. The chief objections to following the policy I have outlined is that the majority of cars do not stand still long enough in the yards so the work may be properly performed, and the labor cost is so high that it is practically prohibitive.

Repacking Boxes while on Repair Tracks, Regardless of the Date Previously Packed—In my opinion, unquestionably the most effective way for the railroads to reduce hot boxes on freight cars to a negligible quantity, would be to adopt a policy of pulling and repacking every journal box on their own cars every time they are on a repair track where a soaking vat is located, or where packing is shipped to and from a central reclaiming plant, and pull and repack foreign cars when stencilled record shows packing more than 12 months old, which would seldom be the case under this practice. My reason for this opinion is, that the packing would never become old and worn completely out as is so frequently the case at present. The greatest output could be obtained from the labor, as packers equipped with a barrow, packing tools and packing, can move along a string of cars on a repair track pulling the packing and return and repack, and do more work in one hour than the same man could do in three hours out in the terminal yard. Only a very few oilers would be required in yards, as with intensive attention on repair tracks, little attention other than the inspection, would be required in yards. The cost of material would be negligible as all the packing could be reclaimed. In order to determine what force is required on the repair track to follow this policy, the nearest basis to use for computation is 10 boxes per man per hour.

Hundreds of hot boxes occur on the railroads daily. In order to determine the cost of these hot boxes, add up the total amount expended on the system for rebrassing, replacing or turning cut journals, car delays, train delays, sending men out on line to rebrass or to apply wheels and divide the total hot boxes into the total amount of money. It will be found the cost will run close to an average of $12 per hot box.

If the amount expended thus for hot boxes is greater than the cost of employing a sufficient number of packers on repair tracks to repack all the boxes, then it is apparent to all that the employment of the additional packers will be an excellent investment.

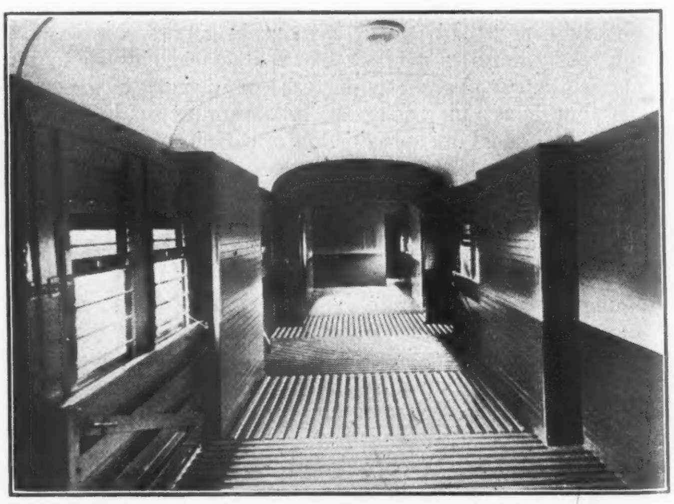
If the total cost of hot boxes as shown above is less than the cost of the labor required, then, obviously, additional investment in labor would be an unwise policy.

Use of Cooling Compounds

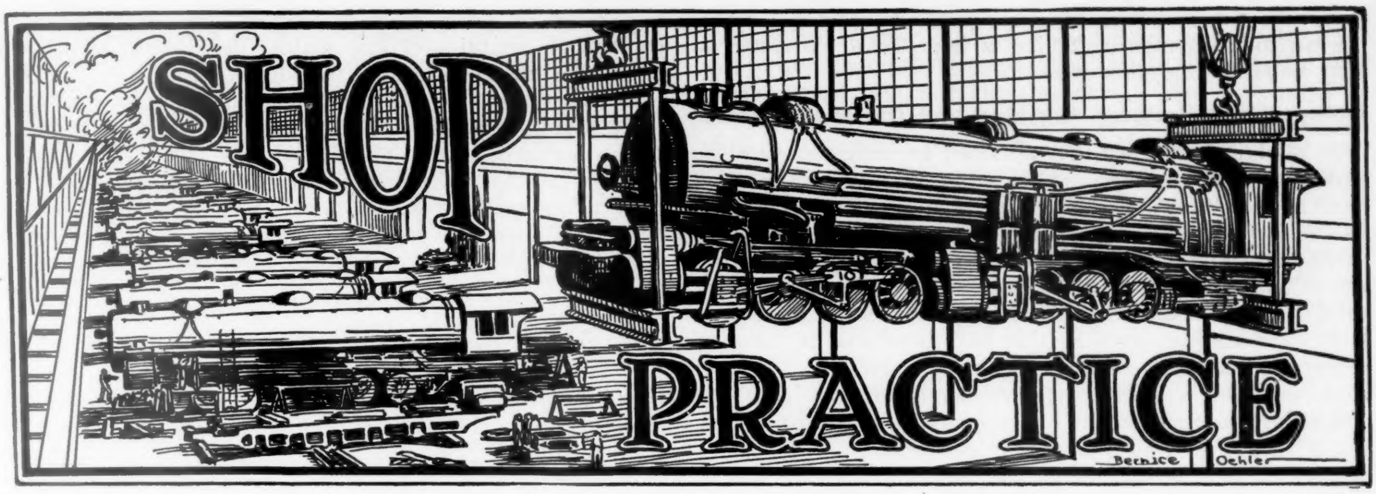
As an emergency measure for treating hot boxes that develop enroute, in order to bring them to a terminal where the hot bearings can be given necessary attention and repairs rather than setting them out on the road, I have found cooling compounds very effective. While we all know that any hot box is expensive, the hot box that entails setting out the car is vastly more expensive than the one that permits the car to move to a terminal where car repair forces are engaged.

On a large number of tests with which I am familiar, 95 per cent of the hot boxes that developed were taken through to the terminal after being treated with a cooling compound, and on a large system, three months after the use of a cooling compound was generally begun, the number of cars set out per month on account of hot boxes was reduced more than 50 per cent.

We cannot eat our cake and have it too. We cannot provide the car foreman with an arbitrary number of men and expect him to eliminate hot boxes entirely, regardless of the fact he has double or treble the number of boxes requiring attention than are humanly possible for his force properly to cover. The problem requires scientific analysis and then sufficient men to meet the situation if we are to suppress the age-old aggravation of the hot box.



Interior of Baggage Car Built for the Central Argentine Railway, Ltd., by the Gloucester Railway Carriage & Wagon Co., Ltd., London, Eng.



Reducing the Cost of Locomotive Repairs

A Discussion of the Application of Modern Production Methods in Locomotive Repair Shops

By William S. Cozad
Shop Supervisor, Lehigh Valley, Packerton, Pa.

THE successful operation of railway repair shops, as well as private industrial concerns, demands occasional changes to meet new conditions and new requirements. Old conditions become obsolete. They are too slow and too expensive. Established purposes change. New demands arise and events take unexpected twists and turns.

General repairs to the same number of locomotives and cars each year are not sufficient to meet expanding business and corresponding increases in the volume of equipment. To take care of this additional equipment adequately and efficiently, either present shop output must be largely augmented, or new shops or additions to old shops must be built.

To enlarge old shops or build new shops involves the expenditure of large sums of money, and when completed, these betterments and improvements, through depreciation and taxes, become an immediate permanent source of expense.

Where there appears to be ample room to increase the output, the possibilities of a more intensive use of present shop buildings and a reasonable expenditure for improved machinery and small tools, increase in competent help and the introduction of improved shop engineering as well as accounting methods, would seem to be a proper subject for investigation.

The character and qualifications of the management of any plant is of primary importance in its successful operation. To work a locomotive at its highest point of efficiency requires a skilled engineman and a good fireman. To secure the greatest possible plant output at the lowest cost requires that each factor of shop organization be highly capable of pushing forward its part of the business.

Successful shop management is not the job of the plant superintendent or of the general foreman only. It is the job of every supervisor in the plant. Each foreman, each gang boss, and each lead man must have a common desire to render exacting service and to contribute his full share to the efficiency of the entire plant.

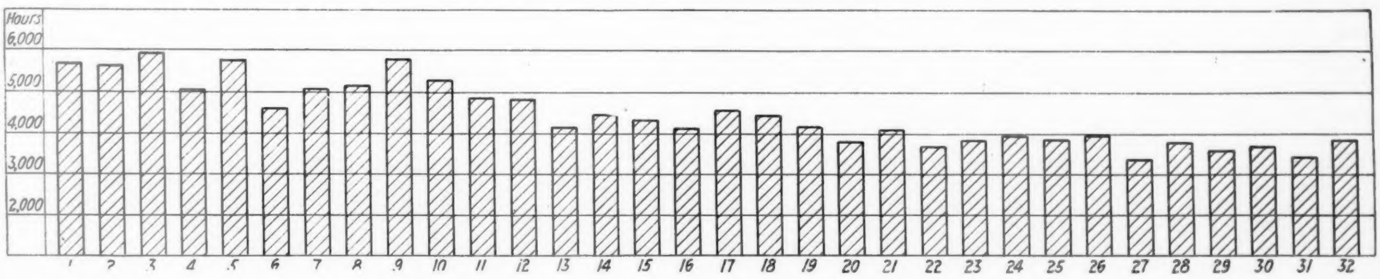


Chart Showing the Reduction in Hours Charged Against 32 Prairie (2-6-2) Type Locomotives for Boiler Repairs—These Locomotives Received New Fire-Boxes and Had General Repairs Made to Machinery

Weekly meetings of the supervising force are a necessity. They immediately inform the heads of the departments of requirements in connection with their part of the work on equipment in the process of repairs. They give each foreman and gang boss an equal opportunity to state his views in reference to any lost motion that may exist and to suggest methods to overcome it. The progress of the work on every locomotive in the shop for repairs may be discussed. Material supplies, tools, prevention of accidents, new methods of doing the work, reclamation of material, grievances, and the best methods of increasing production should be topics for discussion at these meetings. Such conferences place the

man prominently before his associates, who does not measure up to the standard and he is impelled to do better or step aside for the man who can.

Co-operation Between the Men and the Management

It has been contended that workmen are only concerned in making the day's wage. This unnecessarily narrow view has, to some extent, resulted in branding shop efficiency methods in hourly rate plants as impracticable, and the additional claim that production can only be increased by the use of some time-measuring device. The stop watch, however, in the opinion of the writer, has done more to antagonize labor than all other agencies that have been used in the past century in connection with cost reduction processes. A time study man that cannot secure sufficiently accurate time for cost reduction purposes on repair operations without a stop watch should go into some other business.

This system of production which is based on sound economic principles commands the respect of all grades of workmen. It places an agreeable responsibility on each department foreman. While eliminating the piece-rate, premium or bonus features, it still places the workman under a moral obligation to perform a reasonable amount of work in a limited time. The workman was consulted in setting the time and he thus became a party to the contract. It is then up to him to fulfill an agreement which is neither more nor less than faithfully to execute the work assigned him.

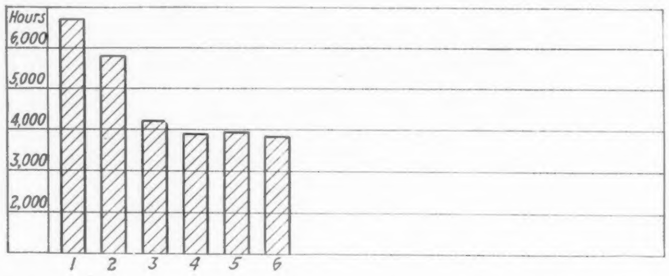
Directing labor in railroad shops is an important business problem. But the feature of most importance is the development of a fair, constructive attitude of mind on the part of the workman.

The natural tendency and purpose of every honest man is, not simply to do well his appointed duty, but also, to defend his employer against loss. This is almost an axiom and all employees should be considered as honest, energetic and a necessary part of the organization to secure the most efficient results.

High wages will not make men loyal. High wages will not increase production. High wages will not solve the labor problem. The fact is, wages have little to do with loyalty. Labor unrest is not the result of either low or high wages, but is due, primarily, to propaganda spread by outside agencies. Poor working conditions and unfair treatment may also add to dissatisfaction. With this existing condition admitted, one of the most important duties of every officer and every loyal worker in the service of the railroads is to employ the necessary means to counteract these evil influences. To attain this end, much personal work among the masses is always a paying investment. The personnel or welfare work, however, that counts the most, both for the company and the employee, is sanitary and comfortable shop conditions, good tools, providing the necessary facilities for producing effective results, and also the recognition of honest effort—giving a square deal.

Occasional efforts at personnel work in flush times will not build up confidence among the workers. Constant attention must be given to such matters, thus establishing a constructive tradition of fair dealing that industrial reverses or outside influences cannot tear down.

Grievances of one kind or another arise at some time in every business concern. Most of them are petty in character. If the employee has no established way to air his troubles, he will talk to his fellow workers about them until they grow to be matters of tremendous importance in his own mind. A man with a grievance is going to talk about it under any and all circumstances. It is a wise management that makes it easy for him to do this talking where he will get a satisfactory hearing and good advice in return.



Reduction in the Number of Hours Charged Against Six Mikado Type Locomotives for Stripping and Assembling

The Application of Efficient Methods

Workmen should be tested as to qualifications for the job, classified as to ability and advanced year by year into higher grades on a basis of length of service or demonstrated fitness. Men are no more alike in their capacity to do useful work than in temperament or intelligence, therefore, a flat rate for all mechanics of a specified profession is unfair and unreasonable. No man should be employed or dismissed from the service except for just cause. Reduction in hours, force or pay should be made in accordance with well understood regulations into which personality does not enter. Strict adherence to these principles will do much to eliminate labor troubles and labor disputes.

One of the direct aims of every successful shop must be to keep good employees in the service and to dispense with those that fall below a reasonable standard of efficiency. The longer an employee remains in the same shops, whether in a lowly or important position, the more he should come to know about the purposes, the conditions and the needs of that shop and the more valuable he should be to it. Frequent changes of employees mean corresponding decreases in profits.

Stability of employment can only be preserved in shops where men are contented, where discipline is rigid but just, where men are placed on work for which they are suited, where no partiality is shown, where the foreman puts himself in the other fellow's place before administering discipline, where appreciation is shown for extra good work in quick time, where special ability is rewarded whenever

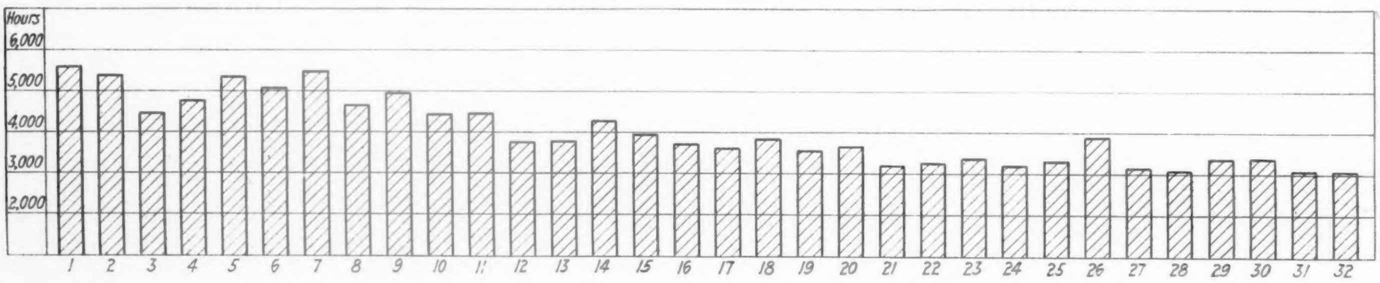


Chart Showing the Reduction of Time Obtained in the Work of Stripping and Assembling on 32 Prairie Type Locomotives

possible, where only promises are made that can be fulfilled, where material is furnished promptly and where safe and sufficient tools are furnished to do the work. Working along these lines, relations will be established with employees on the basis of facts, fair play and faith in each other.

Here is where systematic methods of management must prevail. System is not work but a means of reducing the amount of labor necessary to produce a fixed product. System requires no specialist but permits a few to accomplish much by bringing all hands into intelligent action. System loads no man with labor beyond his proper share but lightens the task of each workman by exactly defining it.

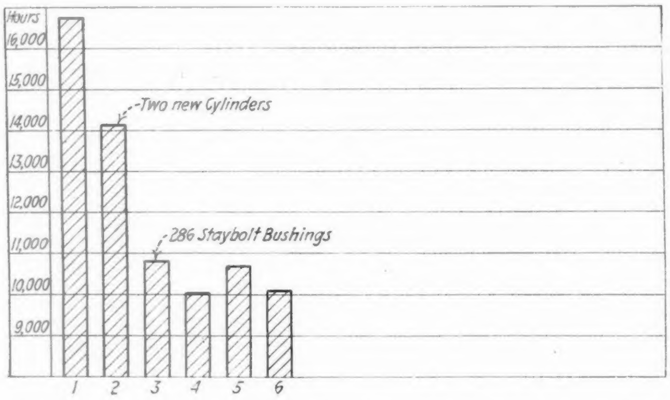


Chart Showing the Reduction in Hours for Applying New Fire-Boxes and Making General Boiler Repairs to Six Mikado (2-8-2) Type Locomotives

The heavy load usually borne by a few faithful employees is distributed evenly upon all. Hard work always begins where system and the application of intelligent methods end.

The Problem of Increasing Shop Production

During the past two years the subject of increased shop production has been up for frequent discussion and there seems to be quite a strong sentiment in favor of adopting means and methods that will place workmen on their honor rather than to subject them to some rigid form of task system.

Briefly stated, this new method consists in separating the repairs on a locomotive into certain well defined parts and, after inspection and decision by authorized parties as to the work to be done on each subdivision, a time limit is set in which to do the work. Gang bosses and workmen then unite in a combined effort to accomplish the work in the time set for the job.

Cost Reduction Methods in a Privately Operated Plant

During the past year the writer had ample opportunity to observe the merits of this system. In many instances it was found to be somewhat loosely applied. It has, however, affected the cost of repairs on a large number of railroads.

The cost reduction methods described in the following paragraphs of this article have not been evolved from any theoretical conception as to what might be accomplished under certain assumed circumstances. They are based on results obtained under actual working conditions, in the modern equipped plant of the Minneapolis Steel and Machinery Company, Minneapolis, Minn., which is privately operated. This is one of the largest manufacturers of structural steel and agricultural machinery in the northwest, and is also thoroughly equipped to do heavy locomotive repair work on a large scale. The records from which data has been taken includes heavy repairs to more than 150 locomotives. One large building in this plant was equipped with pits and utilized as an assembly and erecting shop. The contract was based on a flat rate per hour for all classes of productive labor. The railroad companies were represented in the plant by the usual number of boiler and machinery inspectors who had direct authority only over the amount of repairs to be made and the quality of the workmanship. The large reduction in hours was the result of excellent co-operation between the company officers and the railroad inspectors. A time was set for each division of the repairs as nearly correct as was possible under the circumstances. Efforts were made on the part of the representatives of the railroad to convince the department foremen, and through them, the men, that the repairs outlined could be made in the time set for each classified operation.

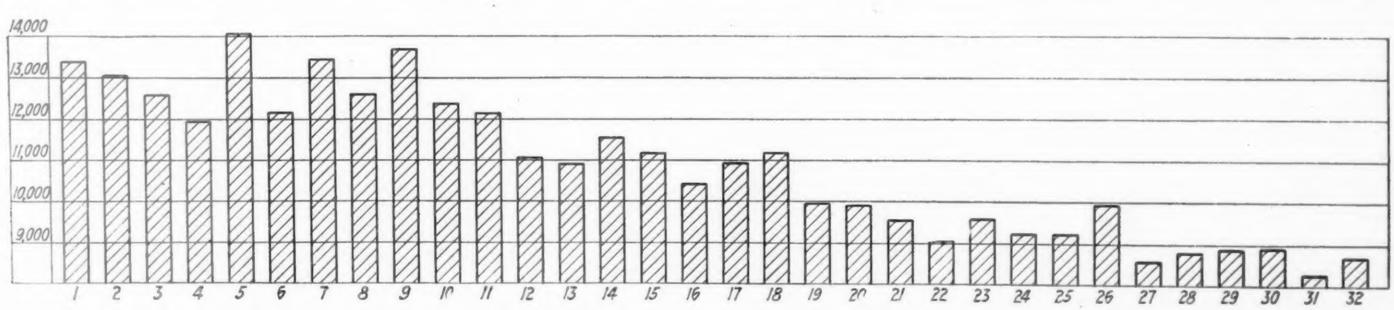
The mark was frequently missed as the aim was not always accurate. The time estimates were based largely on guesswork. There was no master schedule and no time study of scheduled operations had previously been made. The results obtained, however, demonstrated conclusively that a surprisingly large reduction in cost resulted when correct methods were carefully worked out and applied.

Two subdivisions of the classified schedule used in connection with this work are outlined in the next paragraph. In making such a schedule, each sub-division should be carefully detailed and explained, and the work to be done in each department outlined so that a reasonable time estimate is assured.

Stripping the Engine

The work of stripping the engine complete, includes the removing of the main and parallel rods, the driver brake and spring rigging, the wheels, the engine and trailer trucks, shoes and wedges, the ash pan and grates, stoker rigging, the front end and netting arrangement, the steam and dry pipes, the headlight and classification lamps, cab, running boards and pilot, guides, crossheads and pistons and all motion work which includes the valves and valve gear, eccentrics and straps, reverse lever, reach rod, lift shaft and boxes, bell and bell ringer, turbine, jacket and lagging, air pump, air reservoirs, all of the expansion gear, frame braces, tail bars, deck and filling castings.

This list should also include cutting the boiler loose from the frame and delivering it to the boiler shop for a new fire-box and for any other repairs that are required. The total time to be allowed for this work is determined



Reduction in Total Time for 32 Prairie Type Locomotives Receiving New Fire-Boxes and Having General Repairs Made to Machinery

from the summation of the time allowances charged to each of the detailed operations shown in Table I. This list shows the various subdivisions of the entire stripping operation and each item should be given a reasonable time in which to perform the operation.

Table I—Time Allowances for the Detailed Operations in Stripping Engines

Reference number	Description of operation	Time allowance
	Ashpan and grates	
	Air pump	
	Blow-off cock and rigging	
	Boiler cut loose from frame and cylinders and delivered to boiler shop	
	Brake rigging	
	Cab removed and located ready for repairs	
	Cylinder heads and casings:	
	Front head and casing	
	Back head and casing	
	Cylinder cocks and rigging	
	Driving wheels, pedestal braces, shoes and wedges	
	Deck casting	
	Dome casing and cap	
	Engine truck	
	Eccentric rods and straps	
	Eccentrics	
	Engine bell and bell ringer	
	Expansion plates	
	Front end door and netting arrangement	
	Frame cross braces	
	Frame filling castings	
	Guides and crossheads	
	Lift shaft and boxes	
	Lagging	
	Links, link hangers and transmission bars	
	Pilot	
	Pilot draw-bar	
	Pilot bumper beam	
	Pipes, all air, steam, oil and water	
	Pistons cut loose from crossheads	
	Pops removed	
	Rods, main and parallel	
	Running boards	
	Rocker arms and boxes	
	Reverse lever and reach rod	
	Spring rigging	
	Stoker rigging and fire door arrangement	
	Steam and dry pipes, throttle rigging	
	Smoke box braces	
	Sand box and casing	
	Trailer truck	
	Turbine	
	Tail bar arrangement	
	Valve chamber heads and casings	
	Valves and valve rods	
	Whistle and whistle rigging	
	Miscellaneous small parts	

Instructions: Total time should be charged when all items are removed. Allowances should be made in cases where all items are not removed.

The removal of cylinders, frames, deck castings, tail bars, fire boxes, expansion gear, frame cross braces and similar parts should be charged as separate time to be allowed after all work has been completed.

Fire-Box Repair Work

Under this heading should be included all of the following work: burning off the back head and mud ring rivets, burning out all staybolts and crown bolts, ripping the throat sheet, side sheets, back door sheet and removing the crown sheet, removing the back head and mud ring, fire door, frame and arch tubes.

Building and Applying a New Fire-Box.—This includes laying out all the sheets, flanging, shearing, punching, drilling, rolling and shaping; all chipping and countersinking; bolting the sheets in place; heating and lying up all laps and corners, laying out, shearing, welding and applying the door sleeve, bolting all parts together and getting the fire-box ready to drive rivets. Any work necessary to complete this operation that is not specified is included in the estimated time.

Completing the Fire-Box.—This includes chipping and calking all rivets and seams; locating the box on the boiler, applying and riveting the back head; applying the mud ring, tapping out holes; applying and driving all corner plugs; chipping and calking the corners; calking the mud ring and back head seams; riveting the door collar to the back head and chipping and calking. Getting the fire-box ready for the boiler braces, staybolts and crown bolts.

Staybolts and Crown Bolts Applied.—This includes bushing or welding all oversize holes in the outside sheets; drilling and reaming to size; tapping all the holes; preparing for flexible staybolts; renewing the sleeves or making a complete new installation as required. Screwing in staybolts, setting to length, cutting off, driving both ends and opening up the tell-tale holes. Any preparatory work necessary on the edges of the outside sheets and any other details not specified here should be included in the estimated time.

The fire door and attachments are removed, overhauled or replaced. This includes all work in all departments necessary to complete the job.

Study Should Be Extended to Other Jobs

A similar study should also be made for each of the following jobs. This list does not include such items as the booster, automatic train control locomotive equipment, stoker and various other appliances with which many shops have to contend.

1—Barrel of boiler
2—Washout plugs
3—Ashpan and grates
4—Flues
5—Superheater units
6—Front end arrangement
7—Steam and dry pipes.
8—Tender, cistern
9—Tender, frame
10—Tender, trucks
11—Engine truck
12—Trailer truck
13—Driver brake rigging
14—Driving spring rigging
15—Crossheads and pistons
16—Guides
17—Motion work
18—Main and parallel rods
19—Frames
20—Cylinders
21—Driving boxes
22—Shoes and wedges
23—Air pump and air-brake equipment
24—Electrical work, headlight and classification lamps
25—Pipe work
26—Cab work
27—Running boards
28—Pilot
29—Cab fittings
30—Boiler fittings
31—Boiler studs
32—Jacket
33—Lagging
34—Driving wheels
35—Wheeling locomotive
36—Painting locomotive and tender
37—Testing locomotive, hydraulic test
38—Testing locomotive, steam test

Installation of a Cost System

The installation of any cost reduction system presupposes some specific gain to be obtained by its adoption. The primary objects in this case were:

1—A reduction of man-hours in the general repair of cars and locomotives.
2—Harmonious co-operation of shop supervision and employees.
3—Comparative cost of similar work, as between shops.
4—Comparative cost of maintaining similar parts on different classes of engines.
5—A correct charge for labor to the work on which it is employed.
6—A proper distribution of all overhead and non-production expenses.
7—A shop order system that would successfully follow all orders for finished or semi-finished parts from receipt of order to delivery of the finished product to the store room. This includes the accumulation of workmen's time and shop expense in proper form for stores and accounting departments.
8—A simple and inexpensive method of recording used material and showing proper credit for scrap. Overhead expenses up to the point where summaries are turned over to the accounting department for final distribution.
9—A record of facts and conditions maintained so that a quick analysis may have an immediate effect on future work of similar nature.

The methods of accounting for shop orders, material, records of employees' time, etc., should be applied in such a manner as to furnish the accounting department all the information needed to comply with Federal requirements. But, it is believed the shop organization should have jurisdiction up to the point where this information is summarized.

Whatever cost accounting is necessary may be obtained by introducing into the shops a system of engineering accounting. This consists of the formulating and the carrying on of a cost keeping system which embraces the essentials necessary properly to analyze current performance in the shop. This means, not only keeping a record of costs, but using this data to reduce costs. The assistance of the

accounting department, as to methods and requirements, should be obtained in this work.

Table II—Time Allowance for the Detailed Operations in Renewing Fireboxes

Reference number	Description of Operation	Time allowance
	Burning off the rivets in the mud ring, back head and fire door sleeve	
	Burning all the staybolts and crown bolts loose from the outside sheets	
	Ripping the fire-box sheets into sections for convenient size to be removed	
	Driving out the back head and mud ring rivets, removing the mud ring corner plugs, removing the back head and the ring and delivering with the old fire-box sheet sections	
	Allow for any work not covered above	
	Outside sheets, edges or flanges built up by electric welding and chipped to original size	
	Flanging back flue sheet	
	Flanging throat sheet	
	Flanging door sheet	
	Laying out all sheets	
	Shearing and punching all sheets	
	Rolling and shaping all sheets	
	Beveling and preparing the edges of all sheets	
	Drilling and countersinking	
	Setting up the fire-box and bolting together ready for riveting, laying up all corners and seams	
	Applying and riveting the door sleeve	
	Fire-box riveted ready to chip and calk,	
	Fire-box seams and all rivets chipped and calked	
	Locating the fire-box on the boiler	
	Applying the back head bolting and driving rivets	
	Scaling the mud ring and building up the worn places by electric welding and chipping	
	Applying the mud ring and bolting preparatory to reaming holes	
	Heating and laying up the mud ring corners	
	Driving all mud ring rivets	
	Applying all mud ring corner plugs	
	Chipping and calking the mud-ring seams and rivets	
	Chipping and calking the back head rivets and seams	
	Heating and laying up the door sleeve ready to drive rivets	
	Riveting the door sleeve	
	Chipping and calking the door sleeve rivets and seams	
	Applying arch flues	
	Allowance for handling of scaffolding, changing tools and any other miscellaneous items not covered	

Close relationship between responsibility and cost is the active agency required to improve operation. Methods and accounts beyond that which are necessary to provide data for effective control are not justified but exact cost of operation, whatever it may be, is worth the expense to obtain it. The value of shop records, and of time records particularly, depend entirely on the accuracy of their elements and this demands the proper segregation of charges.

Time-keepers must be active, energetic, intelligent workers, accurate in their calculations and exact in specifying on the

Daily record of hours charged against__________

Schedule Numbers and Description of Work

	No. 19 Motion Work		No. 28 Cab Work		No. 35 Lagging		No. etc.	
	Total hrs. 200		Total hrs. 75		Total hrs. 20 —		Total hrs.	
Date	Hrs. used	Hrs. left	Hrs. used	Hrs. left	Hrs. used	Hrs. left	Hrs. used	Hrs. left
3/6	15	185						
9			13	62				
13	4	181	6	56	5	15		

Form on Which the Daily Time Charges Against Each Operation Are Summarized

daily time-card the proper charge, as well as the time and the nature of the work performed by each man.

Workmen, as a general rule, should not be required to make out the daily time-card. Usually, through lack of experience or improper training, they are not qualified to distribute their time correctly. This should not apply to apprentices.

Material orders ought only to be issued by one or more trained men who know the value and the necessity for the parts on order. This will insure a proper distribution as well as give an intelligent check on disbursements.

The overhead should be distributed, as far as possible, by departments, a separate shop expense account being kept for each distinct section of the shop. This should cover supervision, repairs to machinery, heat, light, etc. Effective control is insured by definitely fixing the indirect expense along departmental lines, which establishes individual responsibility and furnishes the department executive a means of analyzing his costs.

Intimately related to this cost reduction system will be the matter of wages and working conditions. Regardless of all cost accounting methods, the cost of performing any one unit of work can never be controlled until it can be predetermined what the wages will be for performing that

PROGRESS REPORT

General Repairs to Locomotives

Name__________ Department__________ Date__________

Please see time allowance and time used to date, operations listed below:

Charge	Schedule number	Description of work	Time		Remarks
			Allowance	Used	

__________ Supervisor Shop Costs

Form for Recording the Progress of Work on Individual Operations

particular operation. To secure this information and to establish master schedules, which must form a standard basis for all comparisons or estimates, time studies are necessary. The systematic study of methods, conditions, and the determination of a reasonable time in which to do the work has a merit which no mechanical or other means can imitate. The capable, energetic, square-deal man engaged in this occupation, if he is a good mixer and practical observer, has a wonderful opportunity to study efficiency of operation. He will smooth out many of the workmen's petty grievances as well as devise ways of improving methods, handling the work, controlling working conditions and many other details which will improve the service. If the investigator has analytical ability and has instinct for the right way to work, he will be able to suggest many improvements in methods and time which will be acceptable to his fellow workmen. He can carry on this work in such a way that the workmen will feel that they have formed a prominent part in the development of the economic changes in time, tools and methods.

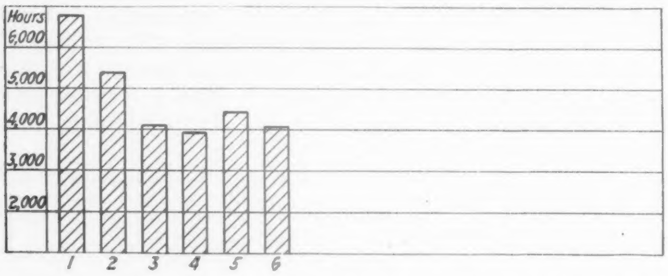
Organization for a Cost Reduction System

The organization necessary to install and operate the foregoing cost reduction system is inexpensive when compared to the savings obtained. It is recommended that the additional local shop organizations engaged in doing extensive heavy repair work be constituted as follows; one supervisor of shop costs, one inspector and estimator, two time study men, two shop time-keepers, one shop accountant, one stenographer and typewriter.

A general supervisor of shop costs should be required to assume responsibility for the introduction of production methods into all repair shops on the railroad adopting the system. He should report directly to the head of the mechanical department and have general supervision of all cost reduction processes in all shops. The local supervisors should report jointly to the general supervisor and the shop superintendent or the master mechanic. The inspector and estimator is subject to double duty as the title indicates. He should inspect jointly, with the department foreman, all parts to be repaired and make a record of the work

to be done, and with the assistance of the supervisor of shop costs, estimate the time required to perform the work, according to scheduled operations and see that each gang boss is advised as to the time allowance and also furnish a detailed statement of the time spent the previous day and the time yet remaining in which to complete the work.

Time estimating should not be made effective until the



Graphic Record of the Reduction in Hours Charged Against Six Mikado Type Locomotives for Boiler Repairs

shop forces are sufficiently acquainted with the schedule and the system in general. The duties of the time study men, time-keepers, shop accountants and stenographers are well known and need not be discussed here. Time study men

TABLE III—A SUMMARY OF THE RESULTS ACCOMPLISHED UNDER THE PRODUCTION SYSTEM

Prairie type locomotives	
Total number of hours charged against the locomotives in period number one,	129,007
Average number of hours per locomotive	12,901
Total number of hours charged against the locomotives in period number two,	217,519
Average number of hours per locomotive,	10,358
Total reduction in hours on 22 locomotives receiving new fire-boxes and other heavy boiler repairs and also heavy repairs to machinery, under the system of determining costs in period number two as against period number one when no fixed system was in use	53,403
Mikado type locomotives	
Total number hours charged against the locomotives in period number one,	30,861
Average number of hours per locomotive	15,430
Total number of hours charged against the locomotives in period number two,	41,641
Average number of hours per locomotive	10,410
Total reduction in hours on four locomotives	20,080
Total reduction in hours, on both classes of locomotives of period number two over period number one:	
Prairie type	53,403
Mikado type	28,080
Total reduction in hours accomplished in eight months	73,483
Total per cent reduction on all classes of repairs	20 per cent

should not be employed until the new methods have had sufficient trial to determine what changes, if any, are necessary to secure satisfactory results.

The comparative data and charts in this article have been taken directly from the records of the Minneapolis Steel & Machinery Co. They illustrate in a forcible way the excellent results obtained by this company through the use of systematic methods in locomotive repairs.

Records were first kept to determine how many hours the different departments of the shop were being charged for each detailed operation. This initial study enabled the department heads to have an individual performance record by which the merits of the new production system could be judged. It might be well to state that while the tables and charts refer particularly to locomotives getting new fire-boxes and other heavy repairs to machinery, other locomotives were going through the shop for class three and five repairs.

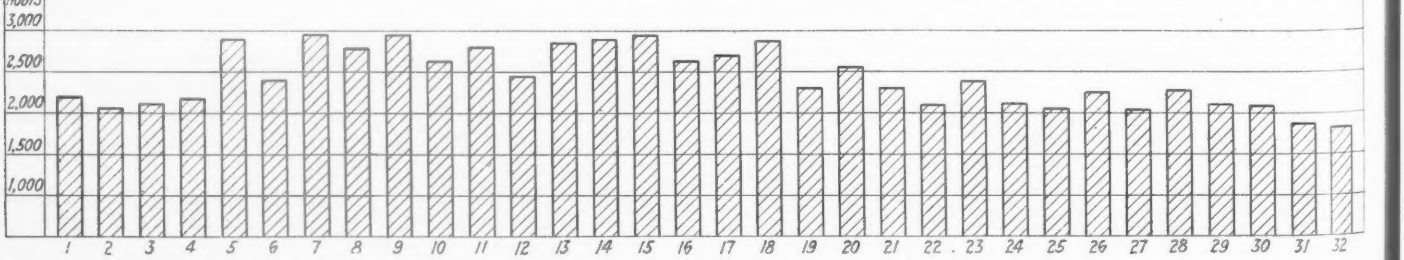
The first locomotive of the series recorded in the data

TABLE IV—ESTIMATED AND ACTUAL TIME ON TWO LOCOMOTIVES OF THE SAME CLASS, RECEIVING NEW FIRE-BOXES, AND THE SAME GENERAL REPAIRS

In column number one, the locomotive was out of the shop October 26, 1923. Column number two, gives data for a locomotive that came out of shop four months later on February 26, 1924. Note the progress made in the actual time reduction in four months time.

		No. 1		No. 2	
No. of Operation	Description	Estimated time, hours	Actual time, hours	Estimated time, hours	Actual time, hours
1	Stripping	220	282	175	142
2	Fire-box	1600	2389	1350	1605
3	Boiler barrel	725	789	450	484
4	Staybolts	1000	917	850	818
5	Crown bolts	450	600	450	360
6	Boiler braces	130	253	250	324
7	Wash-out plugs	50	213	75	62
8	Flues, ash pan and grates	350	375	345	418
9	Front end	100	154	100	158
10	Tender, frame and trucks	470	698	580	443
11	Driving boxes	160	197	140	105
12	Engine and trailer trucks	160	192	190	203
13	Spring and brake rigging	420	435	380	289
14	Guides	100	75	75	80
15	Motion work	460	606	435	394
16	Crossheads and pistons	200	168	170	130
17	Rods	180	280	180	182
18	Frames	250	396	300	370
19	Cylinders	240	276	160	166
20	Steam pipes	120	259	150	157
21	Shoes and wedges	90	84	65	75
22	Wheeling	80	106	90	55
23	Air pump	40	80	50	68
24	Airbrake equipment	100	93	100	84
25	Turbine, headlight, electrical work	54	55	45	46
26	Pipe work	250	301	250	249
27	Cab, running boards, pilot	170	300	225	233
28	Cab fittings	110	96	100	83
29	Boiler fittings	90	277	150	241
30	Boiler studs	140	148	125	159
31	Jacket, lagging	200	276	185	238
32	Driving wheels	170	173	170	136
33	Painting	130	217	150	206
34	Welding and cutting	225	722	375	498
35	Testing engine	100	196	80	128
	Total hours	9,334	12,578	8,965	9,289

given here was put into the shop October 2, 1922. The last engine was turned out June 12, 1924. There was a total of 117 locomotives of which a more or less definite account was kept. Forty-two of this number received new fire-boxes and heavy repairs to machinery. The first locomotive with a new fire-box was turned out May 9, 1923. Other locomotives of which no production record was kept, went through the shop prior to the time the company began turning out fire-boxes. No appreciable reduction in the number of hours resulted, however, until complete daily records were compiled which showed the number of hours charged against these operations by departments for each day. The gang foremen



Graphic Record of the Number of Hours Required for the Machine, Blacksmith, Welding and Cutting, Carpenter and Painting Work on 32 Prairie Type Locomotives

and lead men were advised each day as to the number of hours spent and the number of hours remaining to be spent before the completion of each job.

This arrangement was made effective about September 1, 1923, and for purposes of comparison the data for locomotives receiving fire-boxes and other heavy boiler and machinery repairs, shown in the following summarized tables, has been divided into two periods. Period number one is for locomotives receiving new fire-boxes turned out prior to October 1, 1923, and period number two is for locomotives receiving new fire-boxes turned out subsequent to that date. This class of repairs was selected for comparing cost data on work of a similar nature as to the amount and kind of labor required.

Locomotive Repair Costs

The following items show, in a brief way, the amount of work done on the eleventh and twelfth locomotives that went through the shop after the production system had been installed. This list contains substantially all the information the company had at hand on which to base estimates, as no master schedule was available. These items are representative of the repairs made on all of the locomotives referred to in this article.

THE WORK REQUIRED ON THE ELEVENTH AND TWELFTH LOCOMOTIVES THROUGH THE SHOP

No. 11	No. 12
New fire-box	New fire-box
New front boiler course	New front boiler course
New front flue sheet	New front flue sheet
New installation Tate bolts	Turn tires
Turn tires	Turn all journals
Two new hub liners	Bore both cylinders
Turn all crank pins	Two new piston heads
Turn all journals	One new piston rod
One new side rod	New trailer axle
Bore both cylinders	Two new trailer hub liners
Two new piston rods	Turn two eccentric cams
Grind piston rods	Four new valve bushings
Three new trailed hub liners	New front waist sheet angle
One new eccentric cam	
Bore valve chambers	
Grind valve stems	
One new driving box	
New air pump bracket	

The writer does not contend that these records can be duplicated in modernly equipped railway repair shops where repairing locomotives is an established business and where men, skilled in their respective lines of work are employed. However, with the introduction of specific methods of systematizing the work as outlined in the subdivisions of the foregoing schedule, supplemented by a knowledge of what men can do and of the average time required to perform each part of the work, a 15 per cent reduction in hours could be effected.

As an illustration of what may be accomplished, let us assume a locomotive repair shop having a capacity of 300 general repair locomotives per year. Of this number, we will also assume that 50 engines will get new fire-boxes, leaving 250 locomotives to get class three or five repairs.

The average number of man-hours charged against locomotives getting a general overhauling in a shop such as is assumed above under ordinary working conditions would be about as follows:

Class two repairs,/	7,000 man-hours
Class three or five repairs,	3,500 man-hours

Therefore, 50 locomotives at 7,000 man-hours per locomotive would equal 350,000 man-hours, and 250 locomotives at 3,500 man-hours each would equal 875,000 man-hours, giving a total of 1,225,000 man-hours. A 15 per cent decrease by the introduction of systematic methods of estimating time on scheduled operations and intensive checking to see that the work is completed within set time limits, would result in a saving of 183,750 man-hours. The gross saving to the railroad company at an average day rate of 60 cents per hour, would be $100,250, and the expense of the total additional organization necessary to promote this work should not exceed $15,000 giving a net profit of $85,250.

It is not claimed that the scheme outlined in the preceding paragraphs will work any particular wonders in cost reduction, but it will meet at once the hearty approval of all classes of supervision and labor. It will bring to light expensive processes, develop weak spots and lay a permanent foundation for future scientific and economical development in railroad shop production.

TABLE V—DIVISION OF TIME BY DEPARTMENTS CHARGED AGAINST LOCOMOTIVES RECEIVING NEW FIRE-BOXES AND GENERAL REPAIRS TO MACHINERY. OUT OF SHOP, MARCH 28, 1924

No. of operation	Description	Erecting shop hours	Boiler shop hours	Machine shop hours	Vise shop hours	Blacksmith shop hours	Total hours
1	Stripping	151	...	...	...	...	151
2	Fire-box	...	1,257	8	...	1	1,266
3	Boiler barrel	...	102	...	...	2	104
4	Staybolts	...	708	4	...	...	712
5	Crown bolts	...	397	...	...	15	412
6	Boiler braces	...	140	...	...	40	180
7	Wash-out plugs	...	61	25	...	...	86
8	Flues	...	287	...	...	...	287
9	Ash pan	...	142	2	...	28	172
10	Grates	...	64	2	...	19	85
11	Front end	...	82	4	...	...	86
12	Cistern	...	193	...	...	2	195
13	Tank frame	56	...	1	...	2	59
14	Tank trucks	82	...	4	...	65	151
15	Driving boxes	5	...	26	56	15	102
16	Trailer truck	58	...	19	...	11	88
17	Engine truck	56	...	16	...	13	85
18	Spring rigging	48	...	31	33	108	220
19	Brake rigging	3	...	27	40	40	110
20	Guides	42	...	16	8	...	66
21	Motion work	125	...	120	137	22	404
22	Crossheads and pistons	14	...	74	29	12	129
23	Main and side rods	26	...	63	76	3	168
24	Frames	224	...	32	...	36	292
25	Cylinders	150	...	32	...	8	190
26	Steam pipes	158	...	16	...	1	175
27	Shoes and wedges	49	...	20	...	...	69
28	Wheeling	51	...	...	...	...	51
29	Air pump	10	...	22	40	...	72
30	Air-brake equipment	...	...	4	71	1	76
31	Electrical work	...	...	1	38	...	39
32	Headlight	...	...	...	20	...	20
33	Pipe work	293	...	...	...	5	298
34	Running boards	73	...	...	...	5	78
35	Cab	273	...	...	...	2	275
36	Pilot	29	...	...	...	4	33
37	Cab fittings	...	...	...	108	...	108
38	Boiler fittings	142	...	29	...	14	186
39	Boiler studs	165	...	28	...	...	193
40	Jacket	...	...	...	47	...	47
41	Lagging	196	...	...	...	...	196
42	Driving wheels	107	...	10	...	...	117
43	Painting	214	...	...	...	...	214
44	Electric welding	90	...	...	...	...	90
45	Gas welding	277	...	...	...	...	277
46	Testing	123	...	...	...	...	123
	Total hours	3,296	3,433	636	703	474	8,542

A Dozen Don'ts for Shopmen

1. Don't monkey with a machine "just for fun." A machine can't take a joke.
2. Don't try to operate a machine for the first time without receiving full instructions from some one in authority.
3. Don't shift heavy belts by hand unless you are an expert, and even then great care should be exercised; it is better to use a stick.
4. Don't wear shoes with soles so worn that a splinter or nail will go through and cause serious injury.
5. Don't chip towards anyone without a screen up.
6. Don't stop a planer by half-shifting reversing belt; always stop it by the countershaft.
7. Don't set a lathe or a planer tool while in motion.
8. Don't allow a tool to run by the work so far as to cut into a lathe spindle. A machine may look strong, but it can be very quickly and easily damaged.
9. Don't scar the platen of a planer or make holes in a drill press table.
10. Don't lay files or any tools on the ways of a lathe. Use a tool board—don't cut into chucks or face plates.
11. Don't touch the teeth of a gear or cutters of any kind while in motion.
12. Don't lean against a machine that is running. It is far better to keep a safe distance from any mechanism that is in motion, or likely to be set in motion. Never ride a planer bed.—Railway Journal.

The Centerless Method of Grinding

A Method for Producing Cylindrical Surfaces with No Control of the Center of Rotation

By George W. Binns
Cincinnati Milling Machine Co., Cincinnati, Ohio

THE centerless grinder is a comparatively new development in the machine tool industry. This machine was first conceived as a single purpose tool, but on account of the extremely high productive features of the machine, it was found desirable for other work and was tried out on a great variety of jobs. As the word implies, it is a machine for producing an accurately ground outside cylindrical surface with no apparent control of the center of rotation.

The principal elements of a modern centerless grinder are: A grinding wheel, a regulating or feed wheel and a work rest. The work rest may be provided with suitable guides leading the work in line with the wheels, and receiving it therefrom, and these elements may be arranged and combined in any of a number of different ways, the fundamental principle involved being the same in all. The grinding, due to what may be called the cutting pressure, forces the work against the work rest. It also forces it against the regulating or feed wheel by what may be called the cutting contact pressure. This feed wheel is generally of a material similar to the grinding wheel itself, which provides a surface sufficiently rough to prevent any slippage between it and the work, causing the work to rotate at the same surface speed as the feed wheel itself. Its surface can be quickly renewed by a simple truing operation.

Lateral movement of the work past the grinding wheel when desired, may also be imparted by the regulating or feed wheel. This is accomplished by a relative tilt or angle between the feed wheel spindle and the axis of the work, that is, so that their centers do not fall in the same plane. In cases where the feed wheel has a face contact with the work, the same action is obtained by having the contact with the work at a point slightly below or above its center.

The traverse of the work through the machine can be

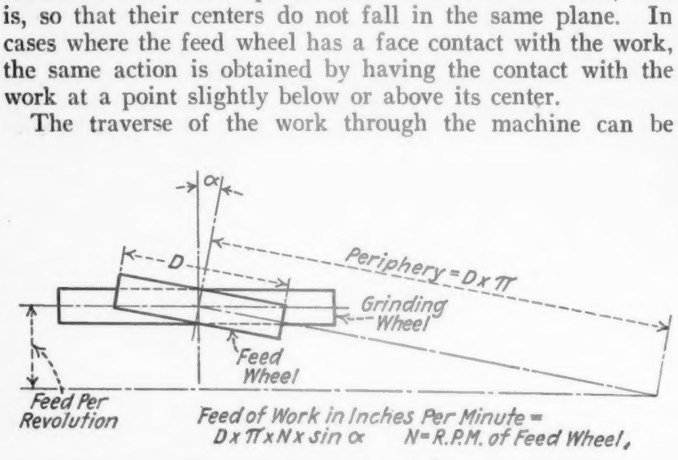


Fig. 1—Formula for Determining Feed Per Revolution

figured by the formula given, the factors being shown in Fig. 1. The feed is theoretical and based on the assumption that there is no slippage of the work whatsoever in its contact with the feed wheel, and it is remarkable how close actual results check with this, the error being usually within two per cent.

The action of the feed wheel makes it possible to accurately control the grinding condition because the rate of traverse of the work past the wheel and the rate of rotation of the work is easily set to any desired amount by simply changing the speed of the feed wheel and the angular setting of its spindle. This adjustable angular setting of the feed wheel corresponds to the feed box on the ordinary grinder for changing the rate of work traverse, while the feed wheel speed control corresponds to the feed box for changing the rate of rotation of the work head.

Advantages Claimed for Centerless Machine

The actual requirement for economical grinding is very much the same on center and centerless machines. There are, however, several distinct differences in the machines, the principal ones being as follows:

The centerless grinder is more productive because the grinding action is practically continuous. The actual rate of grinding is also faster because the work is supported more rigidly at the point of grinding, making it possible to use the grinding wheel to its limit while the center type machine depends principally on suspending the work between centers

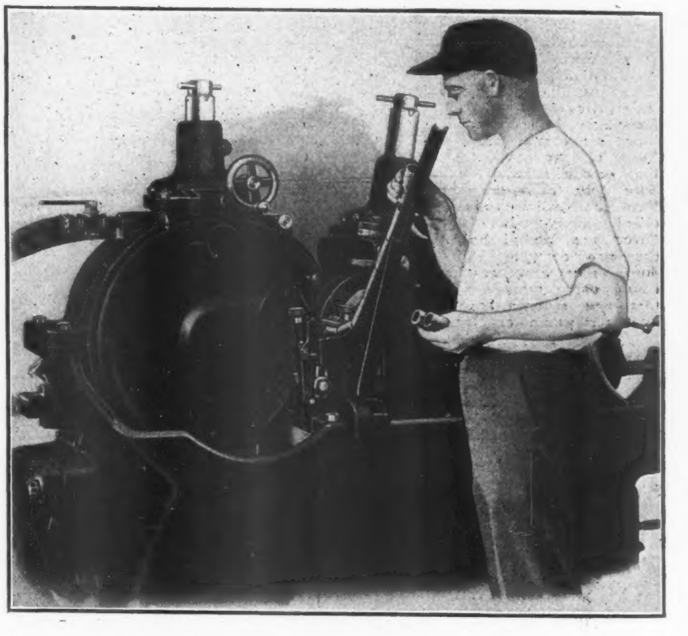


Fig. 2—The Machine Grinding Cylindrical Work by the Straight Through Method

which often limits the rate of grinding otherwise possible. There is a further gain due to the fact that it is not necessary to leave so much stock on the work which is to be ground, as the average job ground on the centerless grinder will clean up with one-half the stock required when grinding on centers. This is due to the fact that the centerless works to the nearest full diameter while center type machines work from a radius. This also permits of an effective saving on the wheel wear, and a further saving is secured since the centering operation is not necessary.

The average gain on production when a job is taken from a center type machine and put on a centerless is over three fold, and in many cases runs as high as ten and seldom below two. It is possible to obtain by the centerless method, work that is more accurate to size and more uniform in quality, due to the fact that the moving elements in the machine for any given operation are reduced to the absolute minimum, and this also materially reduces the skill required of the operator.

On many jobs that have been transferred to the centerless,

such as piston pins and similar work, the limits of accuracy specified have been materially reduced, with a large decrease in the percentage of scrap from the grinding operation.

These results are sufficient to justify considerable effort in making work adaptable to centerless machines. Many of the most successful installations of centerless grinding today are on jobs that a few months ago were considered impossible.

There are two popular methods of centerless grinding, both using the same basic principle. The first and most popular is commonly called the straight through method and is applicable to all straight cylindrical work, such as piston pins and straight rolls. Fig. 2 shows the machine properly set for

Fig. 3—Machine Set for the Shoulder Method of Grinding

this class of work. The second method is commonly called shoulder grinding, and the operation is somewhat different. In this method illustrated in Fig. 3, the work is placed between the wheels to an end stop, the wheels are then closed in to a set stop, thereby sizing the work and as the wheels are released to the original position the work is ejected.

The above principles of centerless grinding are an innovation within the last few years which have revolutionized the art of grinding cylindrical work.

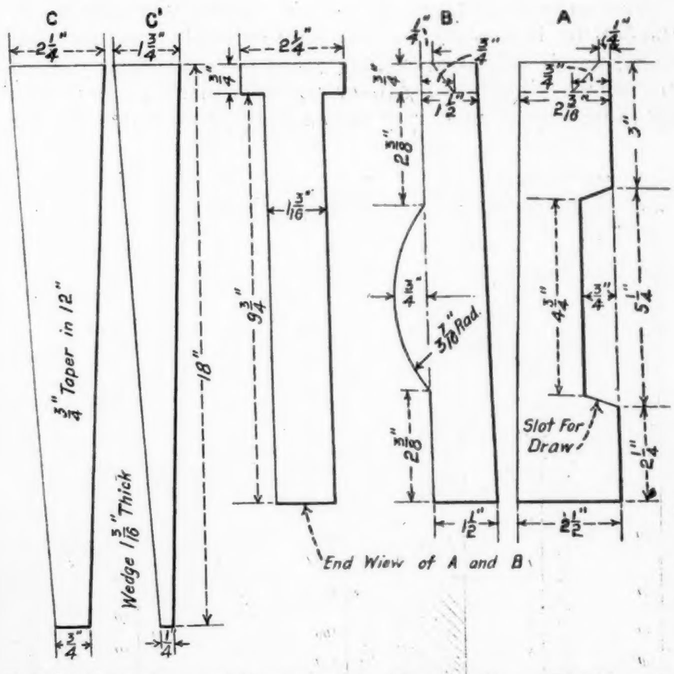
Device for Removing Piston Rods

By Sidney H. Pratt
Special Apprentice, Baltimore & Ohio, Pittsburgh, Pa.

THE Glenwood shop practice bureau of the Baltimore & Ohio has recently developed a combination device which shortens the time required in enginehouse work to draw piston rods and crossheads to a tight fit or to break them apart, from 1½ or 1¾ hr. to 10 or 15 min.

In the employment of this device if it is necessary, for instance, to break the piston rod from the crosshead, after the preliminary operation of removing the key has been performed part *A* is dropped in the keyhole with the slot towards the rear, part *B* is next placed with its radius facing the front and either one of wedges *C* or *C'* is put in between the two pieces. If, then, force is applied by means of a sledge, the piston rod being the only movable body will break its fit with the crosshead. When it is desired to draw the piston rod and crosshead to a tight fit the position of *A* and *B* is reversed in order that the driving force on the piston rod will be towards the crosshead.

It will be noted that by using this combination device, the



Details of Wedges and Keys Used for Drawing Up or Breaking the Piston Rod Fit in Crossheads

necessity of spotting the engine and removing and replacing the main rod and wrist pin is dispensed with. The pieces *A*, *B*, *C* and *C'* are made of tire steel, forged and milled to the dimensions shown in the drawing.

A Useful Horizontal Tank Chart

By W. F. Schaphorst

A CHART that gives the gallons of a liquid in any horizontal tank without the use of tables, formulas, figures or computations of any kind is shown in the illustration. Its application can be better explained by working out an example: How many gallons are there in a tank 84 in. in diameter, 142 in. in length and having in it a liquid 30 in. deep?

Referring to the chart, run a straight line through the 84-in. in column *A*, and the 30 in., column *B*, and locate the intersection with column *C*. By means of the eye follow the radiating "guide lines" to column *D*, locating a second point of intersection. From this latter intersection run through the 142, column *E*, and locate the point of intersection in column *F*. Then from this point run over to the 84 in. in column *H*, and the intersection in column *G* will be found to be close to 1,050 gallons, which is the answer.

One of the principal advantages of this chart is that it takes care of any depth of liquid from 0.1 in. to the full capacity of the tank. All guesswork is eliminated. To make the chart clear there has been included sketches showing the diameter of the tank *D*, the depth of the liquid *H*, and the length of tank *L* with arrows leading from them to the proper columns. By following them no mistake can be made.

The range of the chart is amply wide. It will take care,

of any diameter from 2 in. to 200 in. and of any length of tank from 10 in. to 100,000 in. This chart will give an answer much more quickly than tables or formulæ and is surprisingly accurate. It is more complete than tables because it takes care of every dimension between 2 in. to 200 in., whereas tables generally skip many diameters and lengths giving only 24 in., 28 in., 32 in., 34 in., etc.

Since column *E* takes care of the lengths of tanks up to 100,000 in. it is plain that not only will this chart compute tanks, but it will include long pipes whenever it is desired to compute either their full or partial capacity. Inversely, the chart may be used very conveniently for determining the

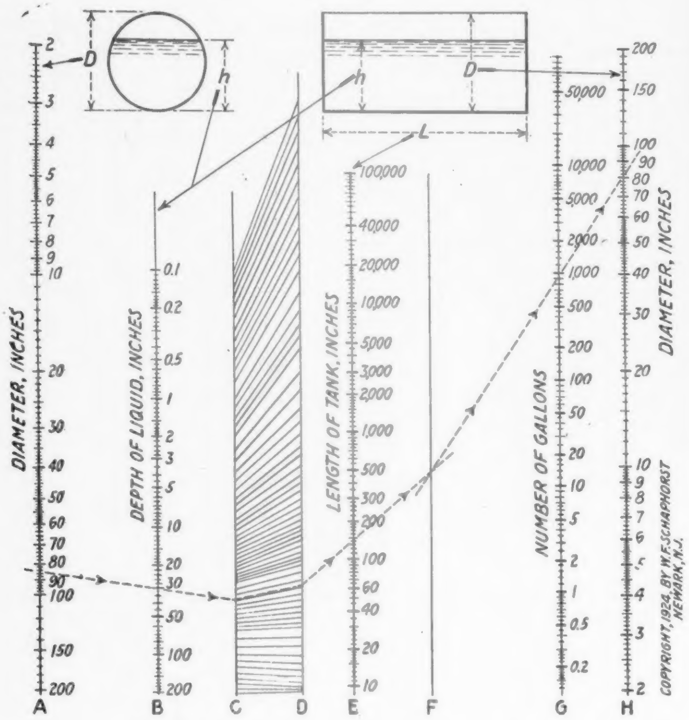


Chart for Determining the Number of Gallons of Liquid in a Tank

length of a tank necessary to hold a given number of gallons where the diameter of the tank and the depth of the liquid are known or are fixed quantities, as is often the case. The method of applying the chart to problems of this character is so obvious that further directions are unnecessary.

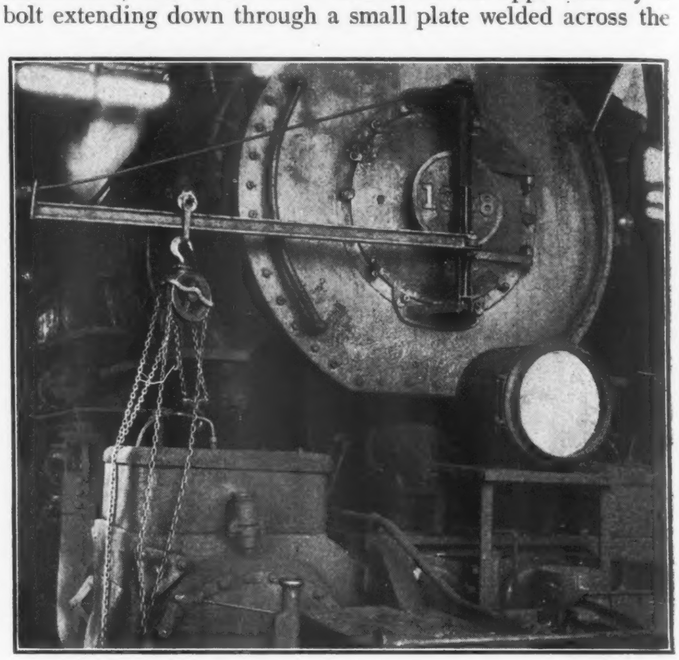
Crane for Removing Cylinder Heads in the Enginehouse

By George J. Lucas

Boilermaker Foreman, Norfolk & Western, Crewe, Va.

SHOPS and enginehouses at many outlying terminal points are not always equipped with sufficient jib cranes to handle emergency jobs. This is especially true if a number of such jobs come in at one time. One of the most frequent jobs of an emergency character that falls to the lot of the enginehouse, is that of cylinder repairs. The illustration shows a jib crane that can be bolted to the front end of a locomotive and made ready for service by two men in from four to five minutes' time. This crane has been primarily designed for lifting off low pressure valve heads and front cylinder heads.

It is constructed of light channel and steel plate and the connections are all electrically welded. The bracket from which the boom is swung consists of two U-shaped plates, cut and drilled to suit the circumference and bolt locations of the door on the front end, and a channel which is welded to these plates and braced on both sides. It extends out far enough to clear the number plate. A pivot bracket for the boom to swing on is welded to the channel, as shown in the illustration, and a tie rod is secured at the upper end by a bolt extending down through a small plate welded across the



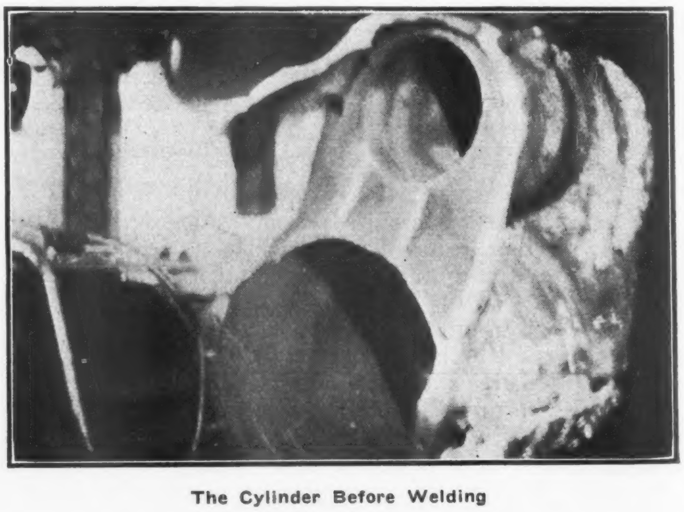
A Handy Jib Crane Which Can Be Set Up by Two men in Five Minutes

top at the bend of the channel. The boom can be made from a light channel or T-iron with a sufficiently wide surface on the top to carry a double-flanged wheel or roller. The usual type of chain hoist may be used with this crane.

After the crane has been adjusted, the work of removing the front cylinder head or low pressure valve head can be easily handled by one man; whereas, to do this work by hand, it generally requires from four to five men. Aside from being a labor saver, the liability of personal injury is also greatly reduced.

Cylinder Welded at Small Cost

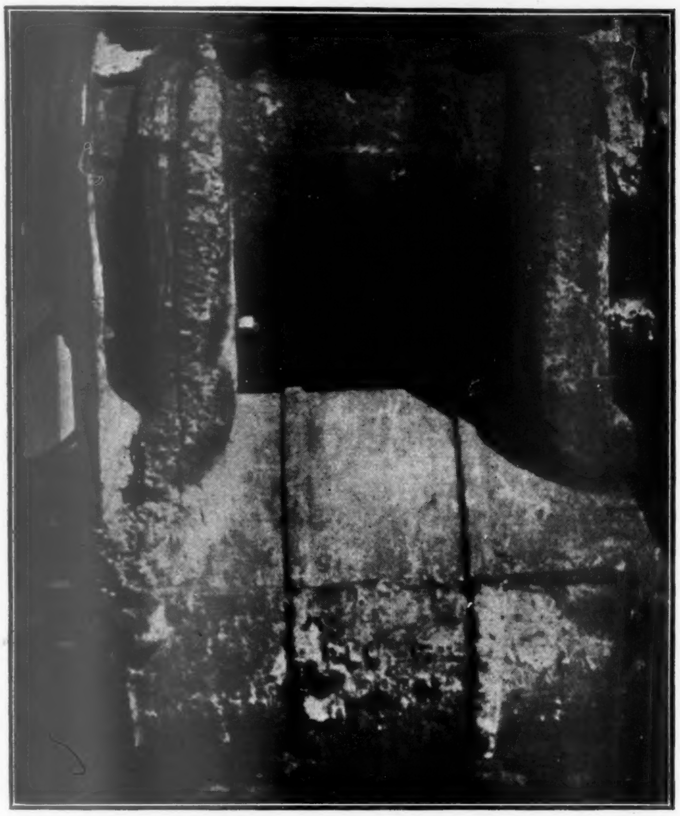
AN interesting job of cylinder welding, from the standpoint of economy, was recently performed in the East Buffalo, N. Y., shops of the Lehigh Valley. The cylinder on the left side of a Pacific type locomotive was broken as shown



The Cylinder Before Welding

in one of the illustrations. The portion broken off was in three pieces, which made the repair work quite difficult. However, after a careful inspection it was decided to weld the broken parts together instead of replacing with new cylinders.

The cracks were chipped out by a machinist and a helper. This work required 20 hours. The cylinder was lagged except at the breaks, and heated with a charcoal fire. On account of the size of the breaks three welders were used to



The Cylinder After the Welding Was Completed

do the work so that the job was completed with the one heating.

The actual cost of this job amounted to only $140.92. The various items are shown as follows:

Chipping, 20 hrs.:	
Machinist	$14.80
Helper	6.11
Three welders, 12 hrs. each	36.54
22 torch hrs	36.30
115 lb. Tobin bronze	41.40
2½ lb. flux	1.37
20 bushels charcoal	4.40
	$140.92

Preventing Shoes and Wedges from Breaking in Service

Locomotive driving box shoes and wedges, especially those with short side flanges, as shown in Fig. 1, frequently break in a manner similar to the crack shown at *D*. This is caused by the projecting end of the shoe, *B*, being forced away from the pedestal jaws by the radius at *A*. This difficulty can be overcome by making a longer radius on the end of the shoe or wedge which is shown by the dotted line at *A*, Fig. 1. Clearances cut, as shown at *C*, will overcome the bad effects of face wear, but this advantage is offset by the weakening of the shoe at a critical point.

A more successful method which may be used to reduce breakage is to weld triangular blocks, *A*, into the corners of the jaw openings, as shown in Fig. 2. An amount equal to the width of the block is cut from the top of the shoe or wedge at *A*, referring to the sketch *a* in Fig. 3, to give an

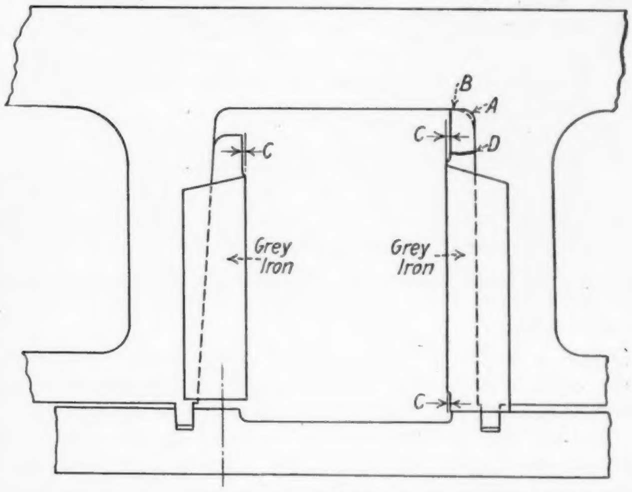


Fig. 1—Sketch Showing the Break in the Shoe Caused by Its Being Forced Away from the Pedestal Jaw Face by the Corner Radius

end bearing. If the shoe or wedge pattern were beveled at the upper end as shown at *D* in the sketch *b*, Fig. 3, an end bearing would be obtained that probably would be better than that shown in Fig. 1, although the bearing area would be less.

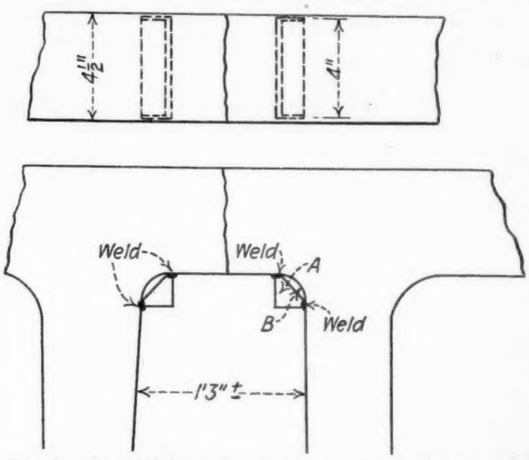


Fig. 2—Blocks Are Welded in the Corners to Give the Shoe or Wedge an End Bearing

Another method that has been recommended to prevent breakages is shown in the sketch *c*, Fig. 3. The frame could be designed with a clearance in the corner of the pedestal

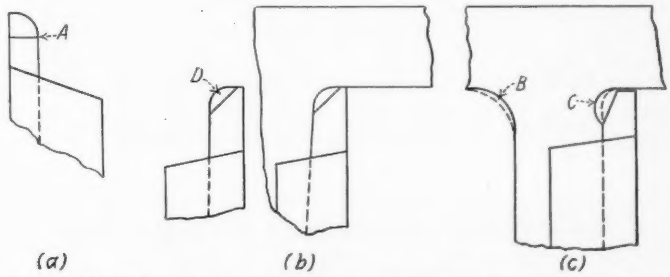


Fig. 3—Sketches Showing Different Methods of Preventing Shoes and Wedges from Breaking at the Ends

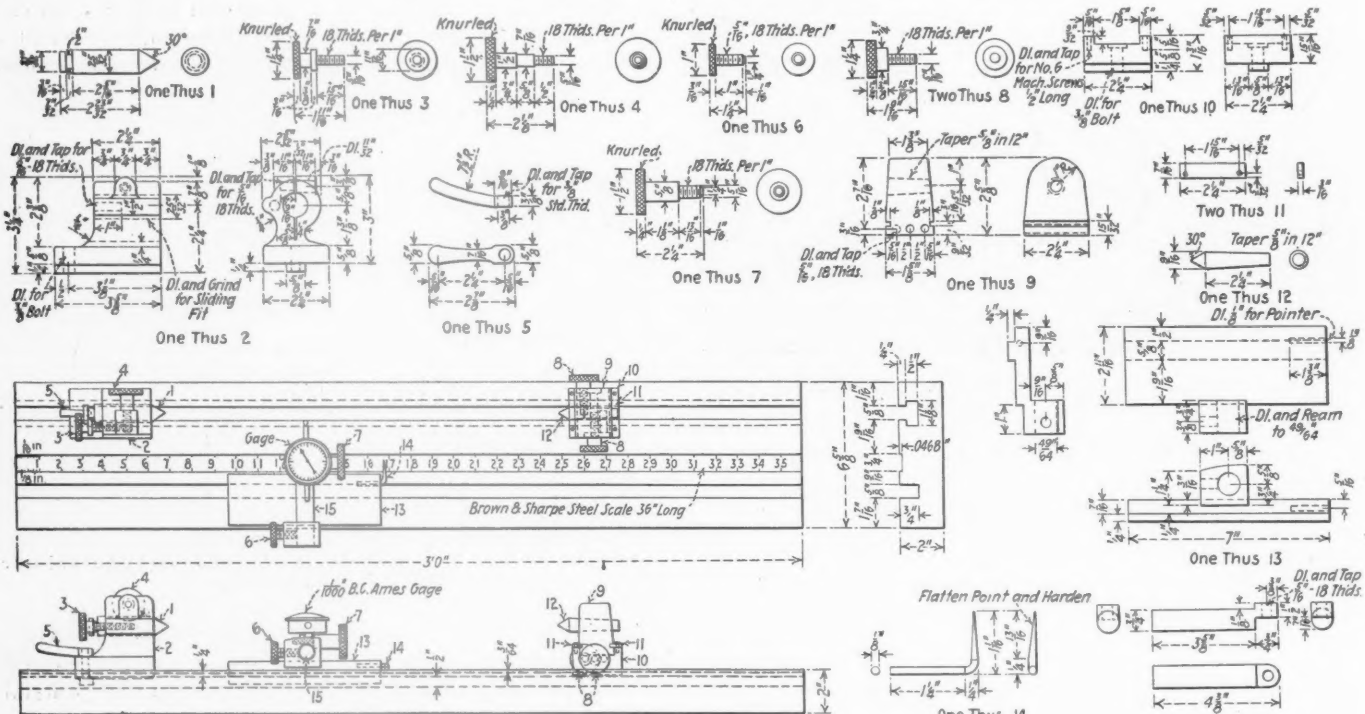
jaw as shown at *C*. The loss in metal could be compensated by additional metal in the outside corner of the pedestal jaw at *B*. The most satisfactory results, however, are being obtained by using the method shown in Fig. 2.

Taper Testing Machine

In nearly all up-to-date railroad shops the bolting-up of a locomotive has become a standardized process. Different sized bolts of one taper, usually 3/16 in. to the foot, are accurately machined and placed in stock. This practice has naturally created the necessity for a machine to test the accuracy of the taper on reamers and bolts in order to facilitate fitting.

The illustration shows the general arrangement and details of a machine which has been designed for this purpose. It consists of a 36-in. base with two sliding stocks equipped with centers, one of which is adjustable. A carriage slides in a separate channel and upon it is mounted a dial test gage which is graduated to read in thousandths of an inch. The position of the test gage with reference to the centers is adjustable.

When a hole has been reamed preparatory to fitting a taper bolt, taken from stock, it often happens that the reamer used does not have a taper which corresponds exactly to the bolt, due, possibly, to carelessness on the part of the toolroom mechanic who grinds the reamers. By the use of this testing machine the taper on the reamers can be easily and rapidly checked up. A reamer of any length, within the capacity of the machine, is fixed between the centers, and while the carriage is moved along the base the length is shown by the reading given by the pointer and the graduations on the 36-in. steel scale, while the exact taper can be figured from the readings of the dial indicator.



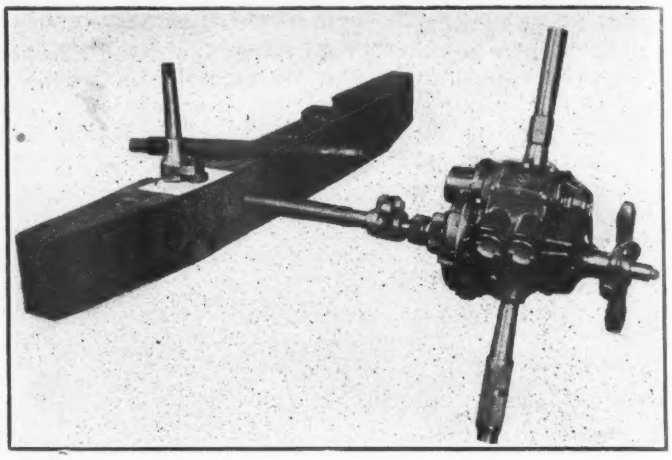
General Arrangement and Details of Machine for Testing the Taper of Reamers

Device for Inserting Long Bolts

By J. J. Sheehan

Roanoke, Va.

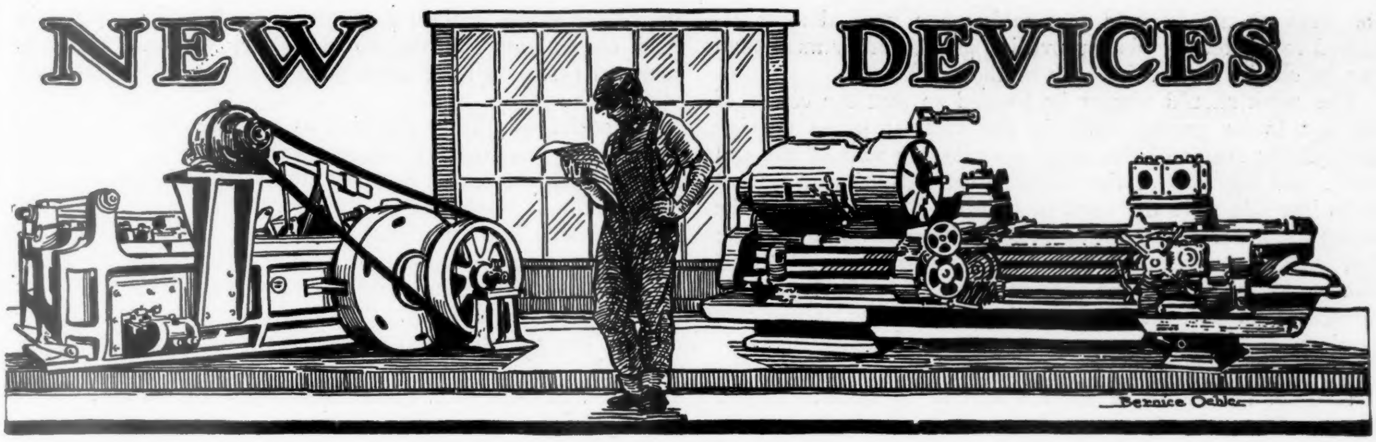
When a mechanic finishes pulling a close fitting bolt, which has threads 1¼ in. by 12 in., through a piece of work with 4 in. of threads, using a hand wrench, he realizes that he has done something. Aside from the element of fatigue, considerable time is also consumed in running all of the wedge adjusting bolts for pedestal binders into place on a Mallet type engine. This also applies to putting flexible staybolts in boilers. The difficulty in this case is increased on account of the round head which is not suitable to take a standard driving socket.



A Driver Which Facilitates the Removal or Application of Long Threaded Bolts

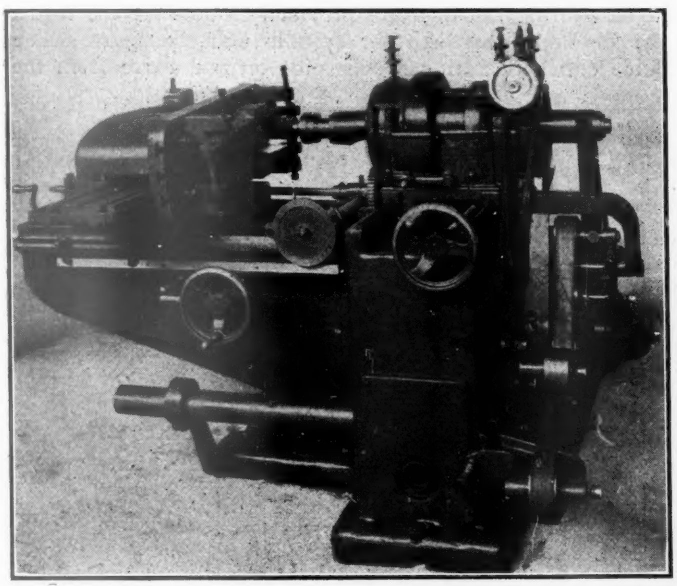
In order to overcome this difficulty a driver with a Morse taper shank was developed which consists of a round hollow socket designed to go over the head of a bolt. This driver, which is shown in the illustration, has an opening on the side to permit an eccentric wheel with a knurled and hardened face to come in contact with the head of the bolt. Thus the harder the pull, the tighter the grip. By throwing the wheel to the opposite side, the action can be reversed and the bolt turned out as well as in. By attaching this device to a pneumatic motor, the labor of inserting long threaded bolts can be reduced to a minimum.

This device saves considerable time and hard labor when running up all of the wedge adjusting bolts for the pedestal binders and also when putting in flexible staybolts in boilers.



An Internal and Link Grinding Machine

The internal grinder, made by the Gisholt Machine Company, Madison, Wis., for grinding holes in locomotive motion work, air pump cylinders and similar parts has been equipped with an attachment for grinding links and link blocks. This attachment greatly increases the field of usefulness of the machine so that, besides being



Gisholt Internal and Link Grinder Set Up for Truing Worn Link

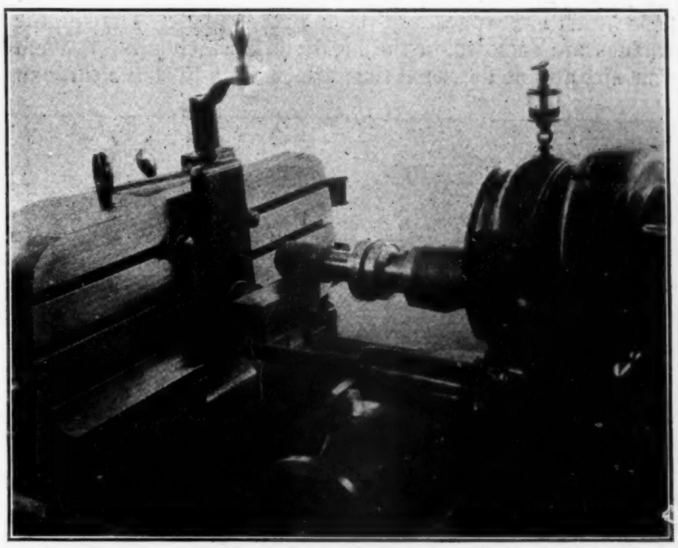
suited to use in large railroad shops, it can be installed with profit in comparatively small shops and enginehouses which may not have enough internal grinding and radius grinding work to justify the purchase of two separate machines.

The cross sliding head of the new Gisholt grinder and the generous travel of the knee give a wide range of adjustment. The table travels back and forth for grinding length and the headstock crosswise for central and center to center adjustment. This adjustment reduces the overhang of the work to a minimum, an important feature when grinding the low pressure cylinders of cross compound air pumps, for example. The machine has a capacity to grind 2¾-in. to 4½-in. holes, 13 in. deep and 4½-in. to 8-in. holes, 16 in. deep. By means of special spindles furnished as extra equipment, 1-in. holes can be ground up to 5 in. deep; also 8-in. to 14-in. holes up to 16 in. deep.

The link or arc grinding attachment is mounted on the work table and consists of a cross slide table in the center of which is located a pivot, carrying a cradle free to rock on the pivot. A rail pivoted in the same horizontal plane as the pivot for the cradle and having an angular adjustment in the vertical plane, controls the rocking motion of the cradle as the cross slide travels back and forth.

The grinding wheel spindle, located in the same vertical plane as the rail pivot, remains stationary so that the combined movement of the cross slide and the cradle will produce a circular arc tangent to the grinding wheel. The center of this arc is located on a line perpendicular to the cradle through the center of its pivot. The angular adjustment of the rail for the desired radius is obtained from a chart mounted on the attachment.

The cross slide table is driven by power from the regular table feed screw which is provided with a clutch for disconnecting the work table power feed. The power movement of the work table and the cross slide, therefore, cannot take



Close-Up View of the Attachment As Used for Grinding a Link Block

place simultaneously, but hand feed is always available for the work table, so that occasionally it can be moved back and forth to insure even wear of the wheel and a parallel surface.

The feed trip and reverse lever controls the reverse motion of the cross slide table through the regular table trip mechanism which also can be operated by adjustable trip dogs on the trip disc when automatic reverse is required.

When grinding internal arcs, such as locomotive links, the work is secured to the fixture plate by means of suitable clamps; but when grinding external arcs, such as link blocks,

the work should be held preferably on a vertical slide attached to the fixture plate providing greater adjustment than can be obtained with the knee of the machine.

The work should always be located so that the center of the arc to be ground falls in the vertical plane passing through the center of the wheel spindle, the axis of the rail pivot, and the axis of the cradle pivot—all of which must be in line whenever the work is set up. The chart gives the set-up angle for selected arcs passing through the rail pivot; that is, the mean arc when referring to locomotive links and link blocks. To bring the abrasive wheel in contact with the surface of the arc, the knee is raised or lowered as the case requires.

If the guide rail is set parallel to the movement of the cross-slide, the radius of the arc will be of infinite length. The machine, therefore, can be used for straight surface grinding without removing any part of the attachment. If desired to grind straight surfaces on work which cannot be held conveniently on the fixture plate, the cradle can be removed easily and the work placed on the horizontal cross slide table.

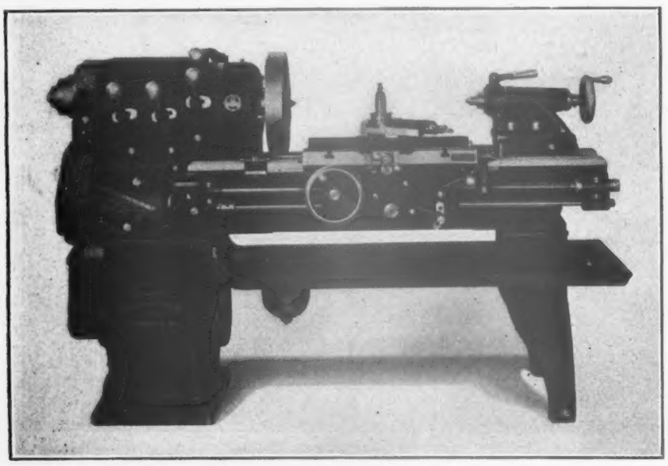
A special spindle is supplied to accommodate the wheels used in arc grinding. When using the machine as a surface grinder with the cradle removed, the regular internal grinding spindle is used, except for heavy duty, when a special heavy spindle is preferable.

The length of the cross slide table is 34 in. and the width 7½ in. The length and width of the fixture plate are 26 in. and 10½ in. respectively. The table has 30 in. cross movement. The surface speed of the table is 2.5 and 4.8 ft. per min. A 2¼-in. to 2½-in. wheel is used with a ¾-in. hole and 3-in. to 4-in. face. The total weight of the machine is 3,100 lb. and a 5-hp. motor running at 1,800 r.p.m. is recommended.

Geared Head Lathe with Helical Gears

THE Monarch Machine Tool Company, Sidney, Ohio, have recently put on the market a geared head lathe with helical gears. The primary object of helical gears in the lathe head is to overcome noise, shock, vibration and tool marks on the work.

The helical gears are alloy steel drop forgings which give a noiseless, smooth, constant transmission of power as three and one-half teeth are always in mesh. The auxiliary shafts are mounted in heavy double row confined radial thrust bearings. All the gear and spindle end thrust is taken against the ball thrust bearings. All changes of spindle speeds are made with three levers operating heavy, double sided jaw clutches. The moving double clutch members slide on squared sections of the spindle and the intermediate shaft. The spindle speeds are all selective and can be made while the lathe is running. The gears run constantly in an oil bath in an oil tight head stock which has no gears in the top cover plate. The spindle bearings are enclosed in the head stock which protects them from dirt and at the same time are easily adjustable through



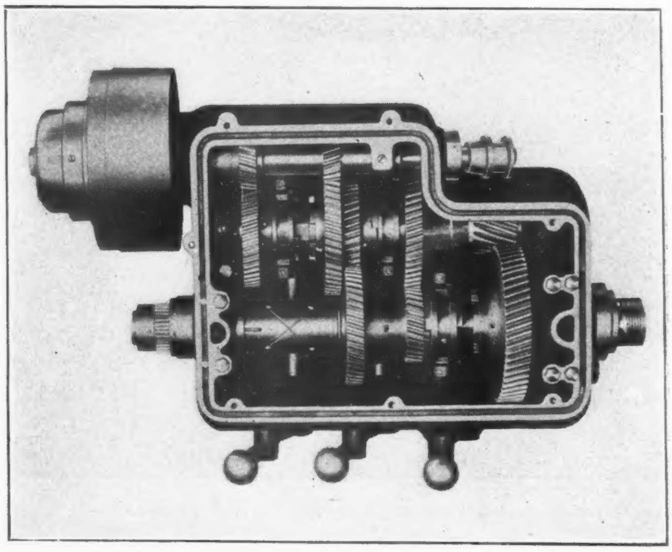
Monarch 14-In. by 6-ft. Ball Bearing Eight-Speed Helical Geared. Self-Contained Motor Driven Lathe

cover plates in the headstock cover. The front and rear spindle bearings are 3 in. by 5 in. and 2¼ in. by 4¼ in., respectively.

The machine is provided with a multiple disc type of friction driving clutch with both a headstock and apron control for starting, stopping and braking the spindle. The spindle and auxiliary shafts with the complete gear and clutch assembly fit into place as a unit.

The clutch has only one point of adjustment which can readily be reached from the outside. It is driven through an endless belt with a ball bearing adjustable idler pulley, or a silent chain.

The headstock contains ten chrome-nickel steel forged gears having from 16 deg. to 18 deg. spiral angle. The two auxiliary shafts run in a double row of heavy ball bearings. Six ball thrust bearings are provided to take all the thrust wear developed by both the spindle and the gears. The double clutch operating spools slide on and drive from the



Inside View of the Eight-Speed Helical Geared, Ball Bearing Headstock, Showing the Multiple Disc Friction Drive Clutch and Gears

large squared sections of the intermediate shaft and spindle. All the gears are in an oil bath and the splash system carries a flood of oil to all the working parts. The spindle bearing cap screws are adjusted by a socket wrench through the removable cover plates in the top cover.

The initial driving shaft, on which the multiple disc driving clutch is mounted, is hollow and through it extends the clutch operating shaft on the front of which a friction cone clutch is mounted. When the friction clutch is disengaged by either the headstock or the apron control lever, the head can be allowed to drift or instantly be brought to a stop at the will of the operator.

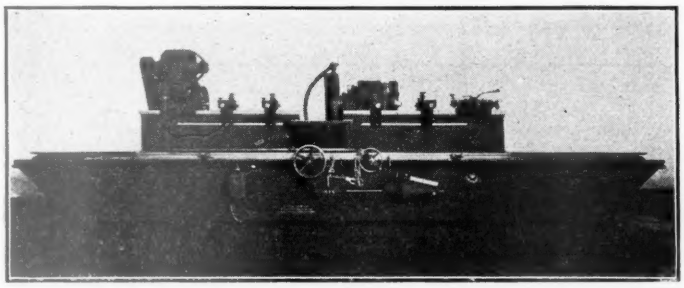
The motor can be located either in the cabinet leg of the lathe or on top of the headstock. It is mounted on a hinged adjustable bracket which provides adjustment for the belt or

the silent chain used for driving. This adjustment is made from the outside. The motor starting apparatus can either be mounted inside or on the rear of the tailstock leg. A 2 to 3-hp., a. c. or d. c. constant speed or adjustable speed d. c. motor not exceeding 1,200 r.p.m. is recommended.

Some of the principal dimensions of the 14-in. by 6-ft. lathe are as follows: Swing over the bed, 14¼-in.; swing of the carriage, 9¾-in.; distance between centers with the tailstock flush, 2-ft. 6-in.; hole through the spindle, 1 9/16-in.; center Morse taper, No. 4; range of threads per inch, quick change, 3 to 46; range of feed per inch, quick change, 7½ to 115; carriage length, 24-in.; size of lathe tool, ⅝-in. by 1 ⅜-in.; speed of geared head driving pulley 545 r.p.m.; weight without the motor, 2,600 lb.

Piston Rod Grinding Machine

A MACHINE designed for grinding locomotive piston rods with the pistons in place has recently been brought out by the Norton Company, Worcester, Mass. It is also suitable for grinding axles, valve rods and any other long cylindrical work within its capacity.



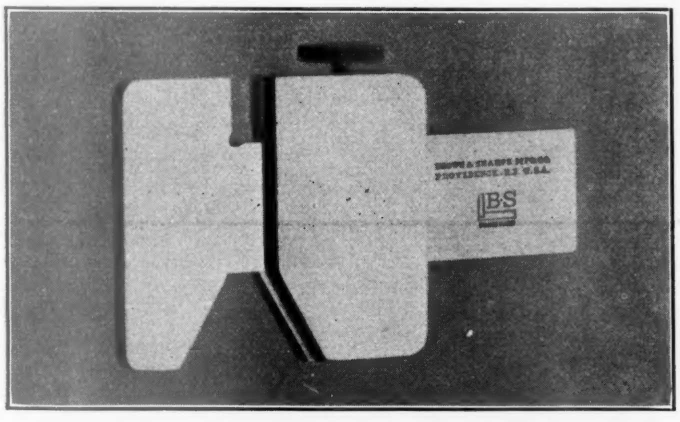
Norton Grinding Machine Provided with a Gap Which Permits the Grinding of the Largest Locomotive Piston with the Head Attached

The machine is of the gap type and is made in three lengths between centers of 96 in., 120 in. and 144 in. with a swing over the table of 16 in. and a gap swing of 40 in. The gap is located in the center of the table and is 19 in. wide. Other widths of gap varying from 13 to 43 in. and positioned at any point along the table to suit the work to be done, can be furnished.

The headstock mounts a 2-hp. motor for revolving the work, which turns on dead centers. This motor is of the variable speed type in order to obtain the necessary changes in work speed. A large diameter screw running in a half nut lapped to fit, produces a wheel feed of micrometer accuracy. The feed is operated by an index gear wheel in front of the machine capable of advancing the wheel to reduce the work diameter by 0.00025 in. or multiples of this amount. The index crank allows of rapid traverse of the wheel head in changing from one diameter of work to another. The grinding lubricant is pumped from a tank in the base of the machine by a pump of the centrifugal type.

Thread Tool Gage and Micrometers for Small Diameters

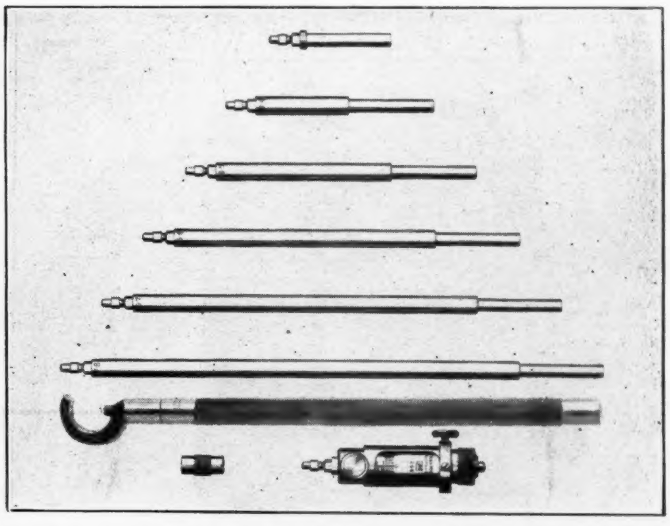
THE Brown & Sharpe Manufacturing Company, Providence, R. I., has recently added to its line of tools a thread tool gage and an inside micrometer. Thread tool gage No. 577 is made of a high quality of steel and the angles of the measuring surfaces are carefully hardened, ground and tested for accuracy. It is possible with this gage to measure or check thread cutting tools from a sharp V to a 1-in. flat. All widths of flats within a given angle can be conveniently obtained with the gage. The three different gages cover the United States, the Acme and the



Thread Tool Gage Which Measures or Checks Thread Cutting Tools from a Sharp V to a One-Inch Flat

Whitworth standards, having the angles of the measuring surfaces ground to 29 deg., 50 deg. and 60 deg., respectively.

To set it, a plug gage or a piece of stock the width of the flat required is inserted in the opening on the top which corresponds with the flat at the top of the angles. The gage with the 29-deg. angle can be used for checking either 29-deg. screw threads or 29-deg. worm threads. As the widths of the flats on worm and screw threads are different, one



Inside Micrometer Provided with a Lock Nut and a Handle for Holding It When Measuring Small Holes

ordinary slot gage is required to take a 29-deg. screw thread tool and another to take a 29-deg. worm thread tool.

The inside micrometer No. 264, shown in the illustration, has a range of measurements of from 2 in. to 8 in. by thousandths of an inch. It is provided with a lock nut which is claimed to be the first inside micrometer of this type. It consists of the head with a ½-in. measuring screw, six rods and one spacing collar. The shoulders on the rods fit in the

micrometer and when in position with the shoulder of the rod against the head, the first one-half in. can be measured from 3 in. to 3½ in. When the spacing collar is in place in the rod, the last ½ in. should be measured from 3½ to 4 in.

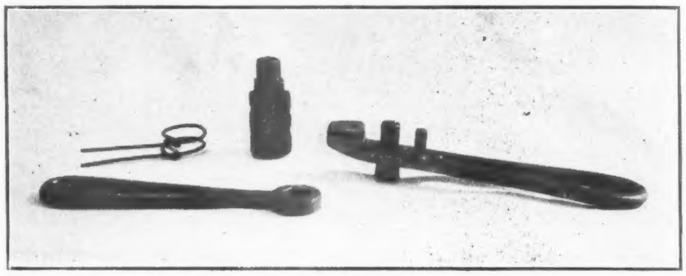
The principal feature of this micrometer is the clamping device. The outer shell of the micrometer is slit in two places. The metal between the two slots forms a shoe which is forced against the micrometer thimble of the thumb screw. This allows the thimble to be locked at any reading and prevents it from turning while being used. The measuring ends of the rods are hardened and so designed that it is possible to adjust them to compensate for wear by loosening the lock nut and turning the screw.

The inside micrometer handle No. 287 has been designed for use in connection with this micrometer. The handle consists of a hook with an adjusting brass plug which is held against the micrometer head by turning the knurled handle. In measuring the diameter of small holes, it is often difficult to hold the micrometer and get accurate measurements. With this handle, the inside micrometer can be inserted in the small holes for a greater distance than by the hand alone. The hook end of the handle fits snugly around the body of the micrometer and the brass plug will not mar the tools.

A Compact Hose Clamping Tool

A COMPACT device for attaching a wire band to any size of hose has been put on the market by the Gunn Manufacturing Company, Keene, N. H. Only three lengths of bands are required to fit any size of hose from ¼-in. to 3½-in.

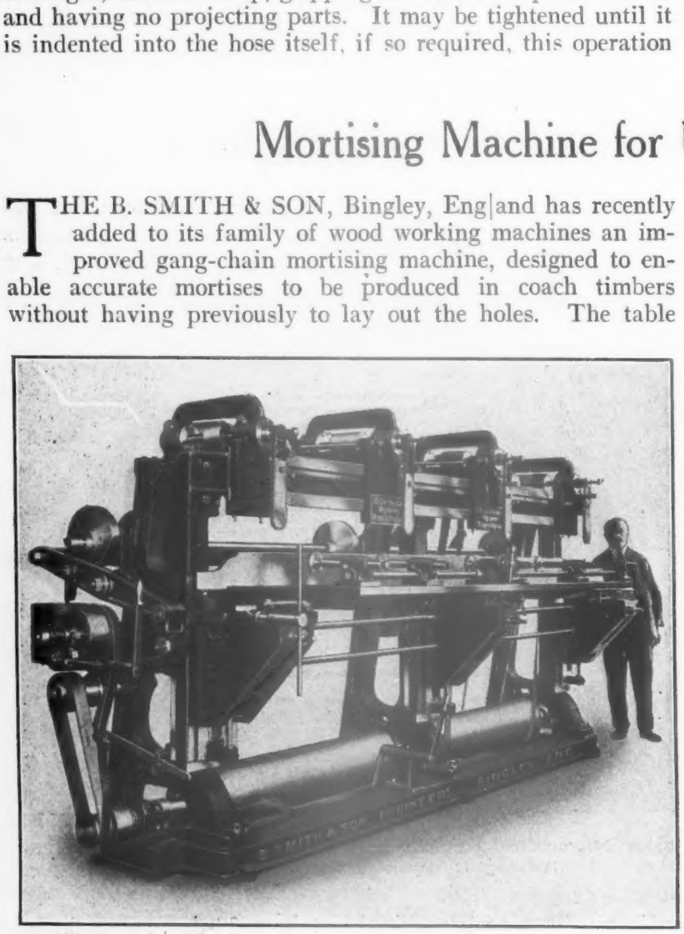
To apply the clamp, bend the wire band around the hose, pulling the ends of the wire through the nose of the tool and continuing it through the slot in the turning pin. Tighten the band by use of the wrench, then twist the ends of the wire until they break off. This leaves a small upright part of the band to be folded over and pounded flat. The result is a tight, smooth clamp, gripping the hose in a perfect circle and having no projecting parts. It may be tightened until it is indented into the hose itself, if so required, this operation depending only upon the strength of the wire used. The clamping can be completed in half a minute.



A Device for Clamping a Wire Band on Any Size of Hose

Mortising Machine for Use in Car Construction

THE B. SMITH & SON, Bingley, England has recently added to its family of wood working machines an improved gang-chain mortising machine, designed to enable accurate mortises to be produced in coach timbers without having previously to lay out the holes. The table will handle two pieces of wood 10½ in. deep and 4½ in. thick and up to 30 ft. long, and will mortise eight holes at one operation without the necessity of moving the timber. This ensures that the holes shall be accurate as regards center distances and is of considerable assistance when building up the framing on mass production.



A Machine Which Will Mortise Eight Holes at One Operation Without Moving the Timber

Mounted upon the top rail of the machine are four main heads which carry the mortise-chain spindles. Each head takes a double-sprocket wheel and two tension bars, these bars being spaced a correct distance apart to produce two mortises at a given distance in relation to each other in the two timbers being mortised. These mortise heads are not fixtures but can be traveled along the top rail by means of a rack and pinion, and in addition to this the two inside heads can be brought forward or taken back, so that mortises may be cut in front of or behind any given center line. The table or fence carrying the timber is fed up to the chains by means of rocking levers and cams, and this system of feed motion allows the chains when entering the timber to enter slowly, and when they are submerged in the wood the feed motion automatically speeds up and completes the mortise. When this is completed the cams have passed their highest point, and are designed to give a rapid downward motion, so that the return of the table is, roughly, 50 per cent quicker than the up feed.

This system of feed motion through cams overcomes to a great extent the danger of the chains splitting or slivering the timber when entering. The feed motion is driven off the left-hand end of the machine by a belt, and the drive is transmitted through a cone friction clutch which is spring loaded, the tension being variable through a pair of check nuts, which can be set at the will of the operator. In the event of a mortise chain breaking while cutting, the tension bar supporting this would come in contact with the timber, and the resistance thus offered to the feed would cause the friction clutch to slip, so that no damage would be done to the machine.

There is a reversing gear fitted into the drive mechanism which enables the table to be reversed and run down to

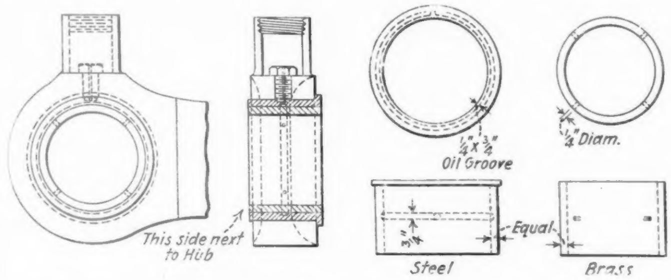
the bottom during any part of the upstroke, and this would also be useful in the event of a chain breaking. There are two rates of feed to the table to enable the machine to cope expeditiously with either large or small mortises.

The table has a constant power feed of 8 in., but there are screw jacks at the three knee brackets, interconnected through bevel gears which allow the table to be raised or lowered from any of the three knee brackets, to accommodate different depths of timber. The main table has a horizontal traverse of 18 in. and a cross-traverse of 6 in., so that any variation is provided for. There are also dead stops to the longitudinal traverse. The clamping motion of the table is all controlled from one point; the operator turns a balanced handle and this brings up four gripping pads simultaneously.

Hoffman ball bearings are used throughout in this machine. In the spindles double-row roller bearings are fitted to the front and also to the back. Ball-thrust washers are put in wherever end thrust is likely to require them. The whole of the gearing is of steel, machine-cut. The net weight of the machine is 5¼ tons, and it is supplied either for belt drive or can be motor-driven through a coupling, direct-coupled.

Combination Rod Bushings for Locomotives

A COMBINATION rod bushing for locomotives has been designed and patented by E. M. Carroll, assistant enginehouse foreman on the Atlantic Coast Line, Sanford, Fla. The object of the bushing is to feed the lubricant to the pin in a simple and effective manner.



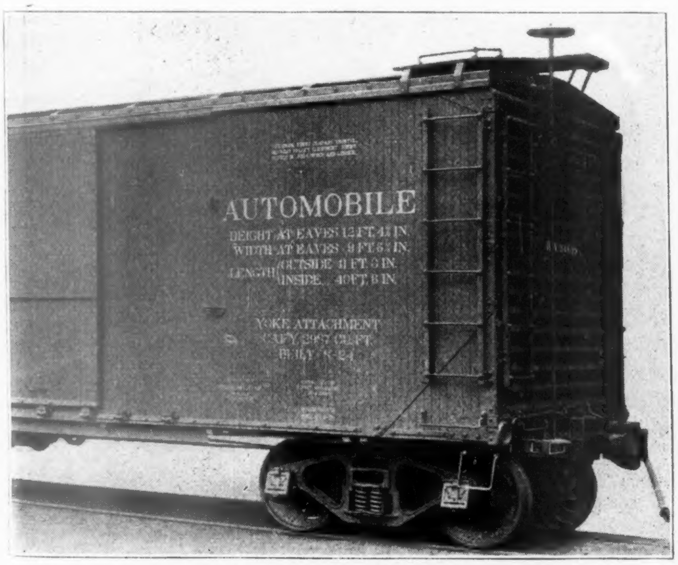
Rod Bushing Which Lubricates in Any Position, Tight or Loose

The drawing illustrates the principle of the bushing. It consists of a cast steel outer bushing and a brass inner bushing. The steel bushing has turned in its inner circumference a ¼-in. by ¾-in. annular groove. The brass bushing has cut in it four radial grease ducts which are arranged at equal distant intervals and are about ¼ in. diameter. These grease ducts lead to the circular groove in the steel bushing which properly distribute the lubricant on the crank pins from the grease cups located on the rods. This arrangement will lubricate in any position, tight or loose.

The steel bushing, after being pressed into the rod, can be electric welded as it does not have to be removed for an indefinite period. It is claimed for the device that it saves labor and material as it requires only half the brass that is usually used for the regular type of bushing. After the first application labor is saved as it is not necessary to remove keepers, drill or tap keeper holes.

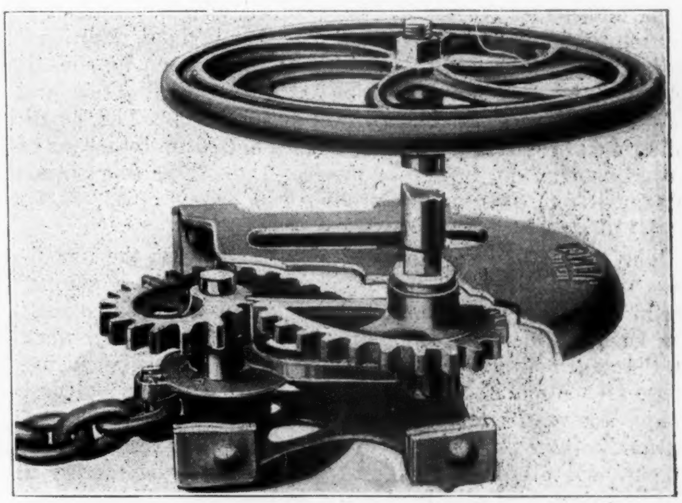
Hand Brake with Quick Take-Up and High Force Ratio

IT is generally recognized that besides simplicity there are two fundamental, opposing requirements of the efficient hand brake; namely, the ability to take up slack quickly and yet give a powerful brake application when the shoes



Jemco Power Plus Hand Brake Applied to Automobile Car

are in contact with the wheels. These requirements have been met by a unique arrangement of cam gears in a new hand brake for freight cars, developed by the Jemco Products Company, Chicago. This brake, known as the Jemco power plus hand brake, is shown in one of the illustrations applied to an automobile car and in the other illustration with the housing cut away to give a view of the helical gears. An examination of the latter illustration will indicate that in release position the ratio of movement of the brake wheel and shaft is approximately one to three of the shaft on which the brake chain is wound. In other words, slack in the chain and brake rigging is taken up rapidly


Housing Cut Away to Show the Helical Gears in Release Position

when the brake wheel is turned through the first one-quarter or one-half revolution. Continued turning of the brake wheel increases the brake shoe pressure until, at approxi-

mately 1¼ turns, the ratio of one to three has changed to three to one and a pressure is obtained between the brake shoes and wheels equivalent to that afforded by 50 lb. air pressure in a 10-in. air brake cylinder. This is assuming a pull of 125 lb. on the brake wheel which can be considered a conservative figure.

The Jemco hand brake can be fully applied without the aid of a brake stick in 1½ seconds and comparative tests indicate the advantage of this brake over the ordinary type of hand brake with sheave wheel. In a specific test it is reported that two composite gondolas, loaded with coal and having a total weight of about 160,000 lb. each, were coupled together in a freight classification yard and handled as a unit over a "hump" with a 2¼ per cent grade. One car was equipped with a Jemco and the other with an ordinary hand brake. The cars were allowed to obtain full momentum in a distance of 1,048 ft., the rider then applying the brake and stopping the cars in the shortest distance possible. The distance traveled to a full stop after the application of the ordinary hand brake was 2,078 ft., and the time required in making the stop was 1 minute and 52 seconds. The test was repeated, applying the Jemco hand brake. In this case the distance traveled was 1,400 ft. and the time 1 minute and 15 seconds. As a result of this and other tests, a large number of Jemco brakes have been applied to new and old freight cars and are now in service on several roads.

The Jemco brake is simple in construction and may be easily applied. It can be slipped over the lower end of the brake mast and the housing secured to the end sill, replacing the ordinary stirrup. The gears are effectively shrouded and supported by the malleable iron frame which not only shields them from damage by falling lading but protects them from ice and snow. All multiplying levers, sheaves, etc., are eliminated. The brake when set by hand is said to be practically as tight as it could be set with a club. The proportions of the helical gears used can be so made as to give any desired braking power.

Vertical Shaper Equipped with a Rotary Table and Improved Tool Head

THE Pratt & Whitney Co., Hartford, Conn., has placed on the market a redesigned 6-in. vertical shaper, designated as the model B. The machine consists of a solid bed which mounts a rotary work table, and a column which supports the vertical ram and contains the ram-actuating mechanism. Angular adjustment is provided for the ram. The machine is designed for either a built-in motor drive or a single-pulley belt drive from a line shaft. In either drive the speed of the main drive pulley is 450 r.p.m.

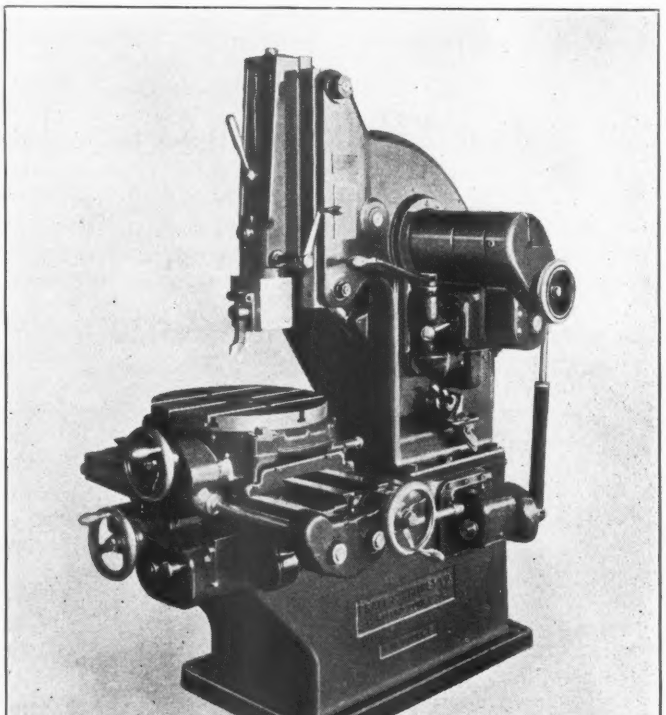
The power is taken into a gear box on the right-hand side of the column, and the selective gear drive provided to the ram is a feature of the new machine. Four speeds and a neutral position are provided and an H-shift lever forms a convenient means of control. Power is taken from the gear box to the vertical ram by means of a large slotted eccentric and follower block which produce the slow power stroke and the quick return motion.

The ram slide and ram form a separate unit on the front of the column. The slide is hinged at the top and has a screw adjustment at the bottom, so that the entire unit may be swung to any angle up to five deg. and locked in position. An angular scale is provided to facilitate setting the ram, and a new feature has been added which permits it to be returned to the true vertical position without additional adjustment. The vertical position of the ram on its slide is obtained by a crank which operates a vertical screw and positioning nut through a pair of bevel gears. The length of stroke of the ram is variable from 0 to 6½ in. by means of an adjustment on the end of the feed cam. The four speeds obtained from the gear box produce ram speeds of 33, 49, 76 and 116 strokes per minute.

The tool head is of a new design, to increase the usefulness of the shaper. The tool post is carried in a clapper mounted so that the thrust of the cut forces it rigidly against the head. This clapper permits the tool to clear the work on the return stroke, thereby prolonging the life of the cutting edge. Attention is called to the elimination of the tool post binder screw, the tool being held by drawing the tool post against it from the back. This feature permits the tool post to pass over the work. The tool head may be rotated a full 360 deg., and solidly clamped in position. This feature further increases the range of work to which the machine is applicable, and makes the setting up of the work much less complicated.

The 19¾-in. rotary table, which is an outstanding feature of the shaper, is provided with 12 indexing notches so that quick indexing may be had for ½, ⅓, ¼, 1/6 and 1/12 of a complete circle. Power feeds for both the longitudinal and transverse slides are regular equipment with the shaper and these feeds are controlled by slip gears. Rotary power feed to the circular table may be furnished.

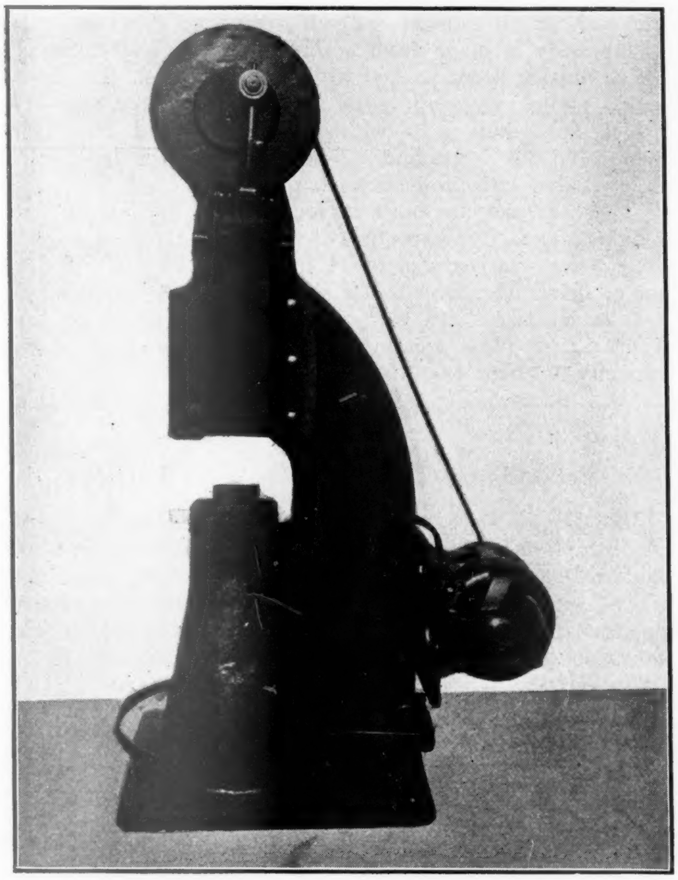
The distance from the table top to the under side of the ram bearing is 10½ in. and the maximum distance between the table and the ram is 15 in. The floor space occupied by the shaper is 53 in. by 68¼ in. and the overall height is 83¾ in. The machine with regular equipment weighs about 4,550 lb.



Vertical Shaper Provided with a Selective Gear Ram Drive and a Rotary Table with 12 Indexing Notches

Self-Contained Utility Hammer

The Beaudry Company, Inc., Everett, Mass., is now marketing a low-priced utility hammer especially suitable as a general service tool for shops where there is not enough blacksmith work to warrant a large investment in a power hammer. These machines are built in three sizes in which the weights of the rams are 25, 50 and 100 lb. respectively. They are cast in one piece and require no extensive foundation.



Beaudry Utility Hammer Provided with an Off-set Anvil

The ram or hammer head is of steel and runs in external elliptical-shaped tracks. Two steel spring arms with steel rollers at the lower end and a helical spring at the top, operate on the curved tracks which lift and throw the ram, which, with an increased speed of the hammer acquires increased travel and force of blow. The full stroke can be had on varying thicknesses of stock and no change of adjustment is necessary excepting for unusually heavy or special work. The hammer has an exceptionally long stroke and may be operated at a very high rate of speed.

The hammer is started, stopped and regulated by a foot treadle extending around the base of the machine. The treadle throws in or out a cone clutch fitted in the hammer pulley and clutch surfaces which are fitted with a brake lining. The ram is carefully machined and fitted to heavy V-shaped guides and is adjustable on its connecting rod for varying heights above the dies. It has an adjustable taper gib for taking up wear. These hammers may be worked to equal advantage from all sides, as the anvil is offset, clearing the main frame casting, which allows bars of any length to be worked either way.

As regularly furnished these hammers may be operated by an overhead belt running at any angle or by a motor attached to the frame as shown. They may be turned into a motor-drive at any time without any mechanical change except for the bolting on of the motor bracket and the attaching of the motor to it.

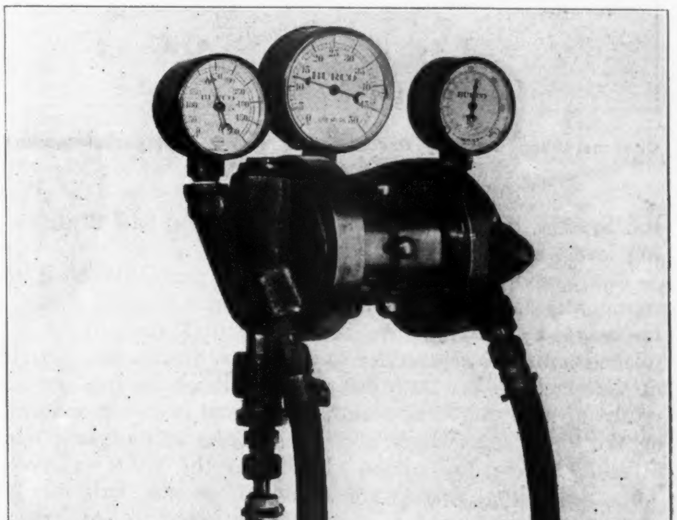
Some of the principle specifications of the largest size hammer are as follows: length of stroke 10 in.; maximum size of stock worked 3 sq. in.; number of blows per minute 300; size of dies 2½ in. by 5 in.; height over all 60 in.; size of motor 3 hp.

Automatic Equal Pressures Two Gas Regulator

With the idea of promoting safety in the use of oxy-acetylene cutting and welding equipment, the Burdett Oxygen & Hydrogen Co., Chicago, has developed the automatic, equal pressures, two gas regulator illustrated. There are three connections to this regulator as indicated, that on the left being the acetylene tank connection, the middle the acetylene torch hose and the right the oxygen torch hose. By means of this regulator with a single adjusting wheel, equal pressures can be produced in the oxygen and acetylene hose lines leading from the regulator to the torch. The regulator is designed to prevent mixed gases in either hose length by producing equal pressures automatically, thus preventing hose fires, hose explosions, the burning out of regulator seats and the possibility of regulator explosions from flame propagation. Moreover, uniform gas pressures delivered to the torch have a tendency to produce a more tenacious and well balanced flame.

The single hand wheel controlling both gases in one regulator makes unnecessary numerous adjustments and readjustments of independent regulators on the oxygen and acetylene tanks. The center gage shows the torch pressure readings for both gases. The two gases flow independently until after they pass the valves in the torch and reach the point of mixture either in the handle or in the head, or in the tips.

The hand wheel when turned with an upward motion brings an equal pressure on the two controlling diaphragms

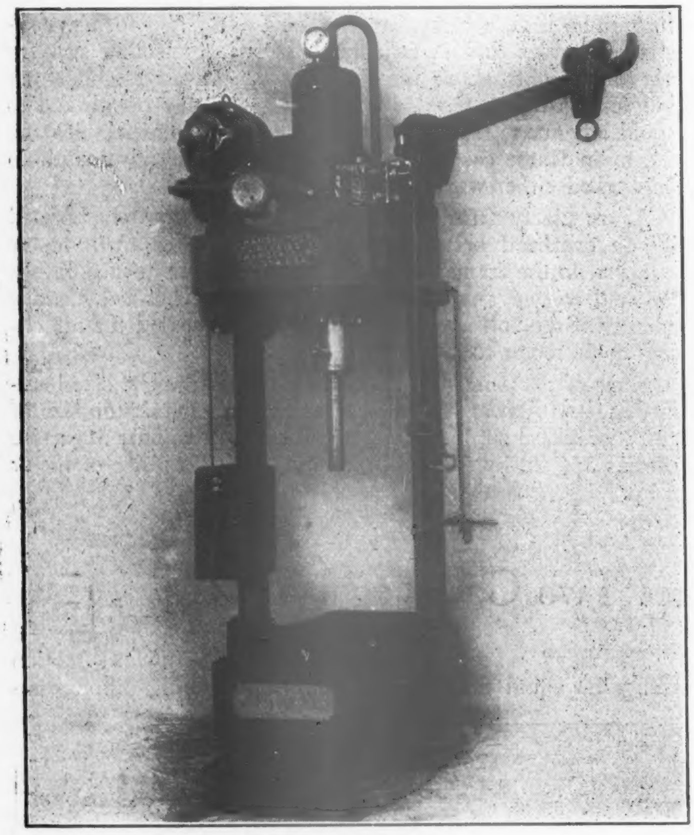


Burco Two Gas Regulator Which Maintains Equal Torch Hose Pressures Automatically

by the compression of a single spring. The thrust of the hand wheel is against ball bearings which reduce the force necessary to turn the control to a minimum. Unequal oxygen and acetylene tank pressures are controlled by the gas flow areas and resistance. The regulator is designed to give ample volume of both gases for welding operations at all times. It is possible also to use this regulator for cutting when the oxygen pressure required is not greater than 40 lb. This is said to make it possible to cut steel billets up to three inches thick with a modern Burco cutting or combination torch.

Hydro-Pneumatic Bushing Press

A LINE of Model B forcing and bending presses, designed to provide a machine capable of filling the exacting requirements of the railroad shop, has recently been developed by the Chambersburg Engineering Company, Chambersburg, Pa. These presses may be used for such work as inserting and removing locomotive driving rod brasses, bushings, link hangers, bending and straightening levers and connecting rods, etc.



Chambersburg Bushing Press Provided with a Hydro-Pneumatic Operated Ram

The hydro-pneumatic feature of the press makes it exceptionally fast in operation. The ram is brought down to the work by air pressure and the actual work is accomplished hydraulically under any pressure within the capacity of the machine. A large weighted pullback assures the fast return of the ram. The motor, pump, and crane are mounted on the top platen which gives free access to the press from all sides. The top platen also forms the water reservoir. The controlling valves are mounted on the side of the machine and so placed as to give the operator an unrestricted view of the work and the gages without changing his position.

The platens are made from heavy semi-steel castings. The base platen is provided with an 8-in. hole in the center to allow the work to go through. It can be changed to suit individual requirements. The cylinder is made from an open-hearth steel casting and is inserted in the upper platen.

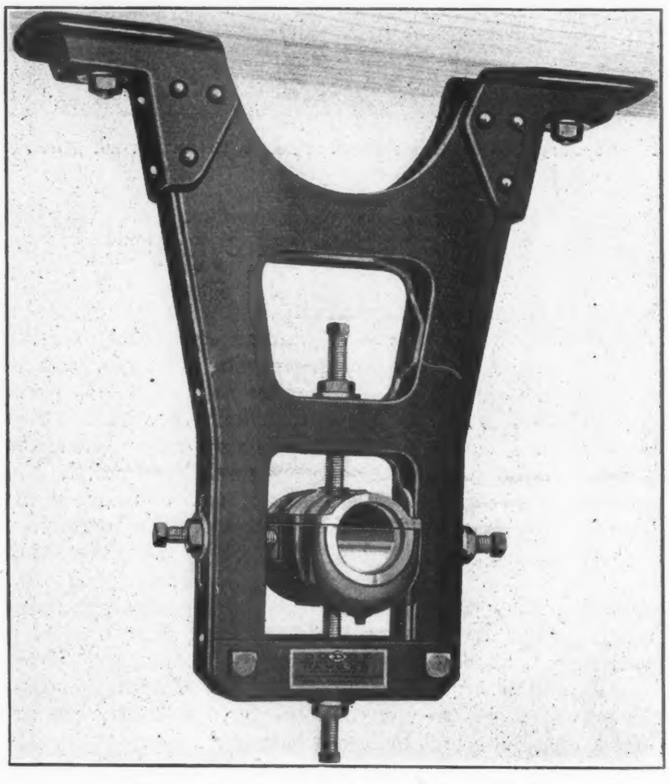
The ram is cast of air furnace iron and turned and finished under a rolling process, which is said to give long life to the packing and prevent corrosion. It is outside packed with an improved U-leather, which permits ready renewal or adjustment without removing the ram. The pump body is made from a solid steel block, the plungers being outside hemp packed with bronze glands. The Monel metal pump valves and seats are of the inverted cage type, which hold their seats without threading and are readily removable for inspection. The press is provided with a safety valve with an overload trip.

These presses are built in four sizes: 50, 75, 100 and 125 tons capacity, respectively. The stroke ranges from 13 in. on the smallest size to 24 in. on the largest. A 5-hp. motor drives the two smaller sizes and a 7½-hp. motor the two larger sizes. In each case the motor speed is about 1,000 r.p.m. The standard crane on all sizes has a lifting capacity of about 1,000 lb.

Pressed Steel Shaft Hanger

THE Dodge Manufacturing Corporation, Mishawaka, Ind., has recently put on the market an improved pressed-steel shaft hanger. The frame is of box construction, welded and riveted together. A malleable iron foot of ample proportions provides a broad, solid bearing and extends downward a considerable distance on the frame, which contributes to the rigidity of the hanger.

The shaft bearing is of the four-point suspension type.



Pressed Steel Four-Point Set Screw Type Shaft Hanger

It is firmly held in place by four oil-tempered setscrews, which are provided with a washer and lock nut. The bearing may be moved in any direction, owing to the fact that the setscrews can be moved in rectangular slots which are cut out in the frame of the hanger. The bearing is provided for

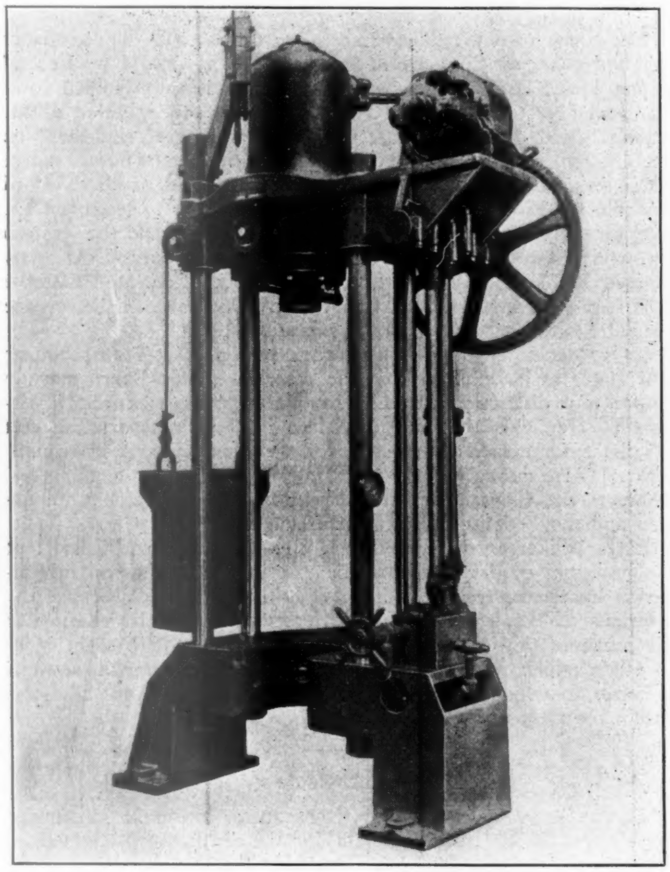
either ring or capillary oilers. The rings may be removed and capillary blocks substituted, or vice versa, if desired. The hanger is finished with a special paint containing varnish.

Rapid Action Hydraulic Bushing Press

The Southwark Foundry and Machine Company, Philadelphia, Pa., has recently placed on the market a rapid action hydraulic bushing press. It is of the four-column type and obtains its rapid action without the need of auxiliary equipment, such as racks or compressed air connections.

The rapid movement of the ram is obtained by means of a triplex pump. Two of the plungers of this pump are of small diameter for high pressure, while the third plunger is of larger diameter, which pumps a large volume of water.

In operation, the ram is brought rapidly down to the



Southwark Hydraulic Bushing Press Equipped with a High and Low Pressure Triplex Pump

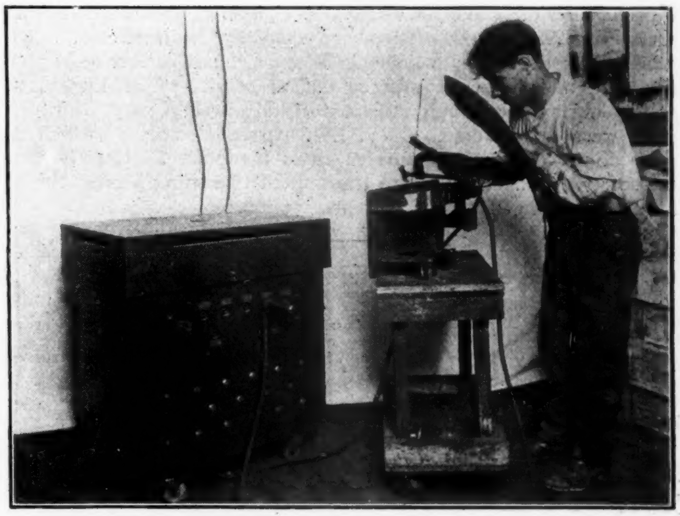
work by means of the large volume of water pumped into the cylinder by the low pressure plunger. As soon as the ram comes in contact with the work, pressure is built up in the cylinder, and this plunger automatically cuts out from the cylinder and discharges into the slack water tank. The pressure for doing the actual work is then carried on by means of the two high pressure plungers. After the operation is completed the ram is returned to its starting point by means of a counter balanced weight.

The bottom platen or work table has the slack water tank as an integral part of it. This platen can be furnished in several other designs from the one shown, to suit special work. The machines are equipped with an overhead crane for a chain hoist which will handle work on both sides of the press. The presses can be furnished in capacities ranging from 30 to 200 tons. The machine is entirely self-contained and only needs to have the motor connected and the slack water tank filled in order to be ready for service.

The Walters Electric Arc Welder

A readily portable arc welding machine has been brought out by the Walters Arc Welding Corporation, New York. The machine is enclosed in a wooden box mounted on castors which makes it readily portable. The welding points are marked directly in amperes on the outside of the casing. This positive marking tends to insure against using the wrong amperage for different materials to be welded.

The maximum and minimum welding currents are 200 and 40 amperes respectively. The machine is, therefore, said to be capable of welding any job, without pre-heating, in cast and malleable iron or steel, from a locomotive frame to a No. 14 gage cab sheet. It is built on the transformer principle so that it will operate on single phase, two phase or three phase current, using 220, 440 and 550 volts, respectively. This makes it very convenient for railroad work. The danger from electric shock is reduced to a



Portable Electric Arc Welder Especially Adapted to Railway Practice

minimum as only asbestos covered wire is used throughout.

The cooling is accomplished by natural ventilation thus eliminating the necessity of a fan. The machine is capable of standing continuous welding at 200 amperes. The current regulation is very close. On short circuit the welding current shows only 10 amperes higher than while the arc is in operation.

The Railway and Locomotive Historical Society has issued its eighth bulletin, a pamphlet of 87 pages, containing, as usual, an interesting variety of information about old locomotives, particularly those of New England. A descriptive list of locomotives of the Old Colony Railroad fills 33 pages. There is a picture of "Locomotive No. 1," the pioneer locomotive of the Stockton & Darlington, which for many years has stood on a pedestal at the Northeastern railroad station in Darlington (England). It is stated that this locomotive, which began its career in 1825 and was taken out of service in 1841, has been sent away from its home a half dozen times, going to various exhibitions, including that at Philadelphia, in 1876, and the British Empire exhibition of the present year.

GENERAL NEWS

Fuel Consumption on the M-K-T—a Correction

In the item on fuel consumption published in the November *Railway Mechanical Engineer*, page 710, the record was credited in error to the Missouri Pacific, whereas it belonged to the Missouri-Kansas-Tex.

Labor News

Wage increases of from two to five cents an hour have been awarded by the Missouri-Kansas-Texas to its shopmen in several classifications.

An agreement whereby shut-downs in the western line shops of the Canadian Pacific were not to exceed two days in November nor three days in December and the following months, was made at a recent conference between officers in charge of the rolling stock on the western lines and representatives of the Federated Shop Crafts.

Locomotive Inspection Report of the I. C. C.

The Interstate Commerce Commission's monthly report to the President on the condition of railway equipment shows that during October, 5,898 locomotives were inspected by the Bureau of Locomotive Inspection, of which 2,847 were found defective, or 48 per cent, and 341 were ordered out of service. The Bureau of Safety during the month inspected 104,515 freight cars, of which 4,347 were found defective, and 1,413 passenger cars, of which 23 were found defective. Fourteen cases involving 33 violations of the safety appliance acts were transmitted to various United States attorneys during the month for prosecution.

Passenger Cars Ordered, Installed, Retired

Quarter	No. installed during quarter	No. retired from service during quarter	No. owned or leased at end of quarter	No. under order or being constructed
Jan.-March	792	679	54,370	1,586
April-June	513	555	54,328	1,450
July-Sept.	553	531	54,349	1,231
Oct.-Dec.	861	948	54,262	832
Full year, 1923	2,719	2,713	.....	....
1924				
Jan.-March	699	431	54,519	970
April-June	698	552	54,668	847
July-Sept.	668	544	54,783	791

Figures in remaining columns from Car Service Division, A. R. A. quarterly report of passenger cars, Form C. S. 55A. Figures cover only Class I roads reporting to Car Service Division.

Pullman Company Keeps Its Shops Clean

The Pullman Car & Manufacturing Company has adopted a novel idea to further its clean-up campaign for eliminating waste materials and rubbish in the various departments and keeping the premises in a clean and orderly condition. In addition to awarding a banner to each department wherein the premises are clean and orderly, a committee designates the dirtiest place in the plant, and a large sign is set up at that place. The sign cannot be moved until the department is made clean and placed in good order.

The plan was first tried at the Michigan City (Ind.) shops in July, 1923, with a sign reading: "This is the Dirtiest Place in the Plant." The psychology of the sign was so effective that it has been impossible to award the sign to that or any other department since that time.

New Pullman Cars for the Merchants Limited on the New Haven

A decorative scheme designed to make the interior of a railroad car as bright and pleasant as a living room in one of the finer homes has been adopted in designing the new equipment which was recently placed in service on the Merchants Limited of the New York, New Haven & Hartford, an extra fare train running between Boston and New York. The trimmings of the cars are done in cream colored enamel. The revolving chairs are of an entirely new design and are upholstered in a lighter shade of fabric than is ordinarily used on Pullman cars, so as to harmonize with the general scheme. The window curtains are silk faced, and the carpets are made of materials to be in harmony with the whole.

Twelve of the new cars have been received from the Pullman Company. The chairs have been arranged so as to be opposite a separate window. Other features are a new decorative grill over the steam pipes, an improved ventilating system, and a newly designed ladies' retiring room which is distinctly more commodious and affords greater privacy.

Labor Board's Powers Upheld

The power of the Railroad Labor Board to compel the attendance and testimony of witnesses at its hearings was upheld by Federal Judge James H. Wilkerson at Chicago in a decision handed down on November 6. The court refused to quash the petition of the Labor Board demanding that J. McGuire, general chairman, on the Chicago & North Western, of the Brotherhood of Locomotive Engineers, and D. B. Robertson, president of the Brotherhood of Locomotive Firemen & Enginemen, be compelled to testify in the long pending wage dispute between the enginemen and the western railways. Immediately after the decision was announced, Attorney Donald Richberg, representing the brotherhoods, declared that the case would be appealed and would eventually be taken before the United States Supreme Court if necessary.

In his decision, Judge Wilkerson says that the Transportation Act states in plain terms that the Railroad Labor Board may go before any district court with complaints against stubborn witnesses. He holds that the provisions in the Transportation Act for the enforcement of subpœnas of the Labor Board are constitutional. He quotes numerous precedents to sustain his ruling and refers to the Clayton Act and the Interstate Commerce Commission and the Federal Trade Commission laws.

Judge Wilkerson declared that it is now "firmly established that the processes of the court may be exercised in aid of an investigation by administrative bodies. It does not follow, because the decisions of the board are not enforceable under the statutes in the courts of the United States, and are merely published in order to guide public opinion, that the proceedings in court to compel evidence on which to place the findings of the board are advisory, within the means of the cases cited."

Court News

Squeaking Air-Pump Not Defective.—In an action under the Federal Boiler Inspection Act for the death of an engineman, the New York Appellate Division holds that the burden was on the plaintiff to prove that the appurtenances of the locomotive were in proper condition and safe to operate in the service to which it is put, and also the railroad's failure to keep them in such condition. The fact that the air pump squeaked and groaned was not a defect, but a condition requiring lubrication by the engineman. The statute does not require a perfect but only a proper condition, and a different standard might govern a locomotive engaged in yard service, or one put to another service.—Luce v. N. Y. C. & St. L., 205 N. Y. Supp. 273.

Decisions Under Federal Employers' Liability Act.—The New York Appellate Division holds that an employee, engaged in repairing a locomotive used wholly within the state both for interstate and intrastate traffic, withdrawn from service and in the enginehouse repair shop for five days, the repairs consisting in repairing worn tires, was not engaged in interstate commerce.—Conklin v. N. Y. C., 206 App. Div. 524, 202 N. Y. Supp. 75.

The Circuit Court of Appeals holds that a machinist and his helper, engaged in making, in an enginehouse, the usual running

repairs on a locomotive engaged in interstate commerce, on the layover period between trips, the locomotive not being withdrawn from interstate commerce for the purpose of making the repairs, were engaged in interstate commerce.

Although the helper, when injured, had discontinued his work and was bound for lunch, he was still engaged in interstate commerce within the act.—B. & O. v. Kast, 299 Fed. 419.

The New York Court of Appeals holds that a railroad employee, killed by electric shock when oiling an electric crane in the railroad shop, the crane being partly used to repair locomotives and cars engaged in interstate commerce, was not within the act.—Tepper v. N. Y., N. H. & H., 238 N. Y. 423, 144 N. E. 668.

MEETINGS AND CONVENTIONS

The American Society for Testing Materials has selected the Chalfonte-Haddon Hall, Atlantic City, N. J., as the headquarters for its next annual meeting, which will be held on June 22-26.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION.—F. M. Nellis, Room, 3014, 165 Broadway, New York City.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—C. Borcherdt, 202 North Hamlin ave., Chicago.

AMERICAN RAILWAY ASSOCIATION, DIVISION V.—MECHANICAL.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

DIVISION V.—EQUIPMENT PAINTING DIVISION.—V. R. Hawthorne, Chicago.

DIVISION VI.—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey St., New York.

AMERICAN RAILWAY TOOL FOREMAN'S ASSOCIATION.—G. G. Macina, 11402 Calumet ave., Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS—Calvin W. Rice, 29 W. Thirty-ninth street, New York. Railroad Division, A. F. Steubing, Bradford Corp., 23 West Forty-third street, New York.

AMERICAN SOCIETY FOR STEEL TREATING.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

CANADIAN RAILWAY CLUB.—C. R. Crook, 129 Sharron St., Montreal, Que. Regular meetings second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal, Que. Next meeting December 9. Paper on Railroad Location will be presented by G. S. Gyowski, chief engineer of construction, Canadian National.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, Great Northern Hotel, Chicago, Ill.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—R. E. Giger, 721 North 23rd street, E. St. Louis, Ill. Meetings, first Tuesday in month, except June, July and August, at the American Hotel Annex, St. Louis.

CENTRAL RAILWAY CLUB.—H. D. Vought, 26 Cortlandt Street, New York, N. Y. Next meeting December 10. Paper on Terminal Operation will be presented by R. L. Scott, trainmaster, New York Central.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—A. S. Sternberg, Belt Railway, Clearing Station, Chicago.

CINCINNATI RAILWAY CLUB.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meetings second Tuesday, February, May, September and November.

CLEVELAND STEAM RAILWAY CLUB.—F. L. Frericks, 14416 Adler Ave., Cleveland, Ohio. Meeting first Monday each month at Hotel Cleveland, Public Square, Cleveland.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. B. Hutchinson, 6000 Michigan Ave., Chicago, Ill.

INTERNATIONAL RAILWAY GENERAL FOREMAN'S ASSOCIATION.—William Hall, 1061 W. Wabash St., Winona, Minn.

MASTER BOILER MAKERS' ASSOCIATION.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Regular meeting second Tuesday in month, except June, July, August and September. Copley-Plaza Hotel, Boston, Mass. Next meeting December 11. A paper on Ancient Trails and Modern Highways will be presented by W. L. Lanigan, general freight traffic manager, Canadian Pacific.

NEW YORK RAILROAD CLUB.—H. D. Vought, 26 Cortlandt St., New York. Meeting third Friday of each month except June, July and August at 29 West Thirty-ninth St., New York. Next meeting December 19. Annual dinner. Dr. David Friday will be the speaker.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y. Regular meetings, January, March, May, September and October.

PACIFIC RAILWAY CLUB.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Regular meetings second Thursday in month, alternately in San Francisco and Oakland, Cal.

RAILWAY CLUB OF GREENVILLE.—F. D. Castor, clerk, maintenance of way department, Bessemer & Lake Erie, Greenville, Pa. Meeting last Friday of each month, except June, July and August. Next meeting December 5. Paper on "The Ice Age" will be presented by F. R. Layng, engineer of terminals, Bessemer & Lake Erie.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August. Fort Pitt Hotel, Pittsburgh, Pa.

ST. LOUIS RAILWAY CLUB.—B. W. Frauenthal, Union Station, St. Louis, Mo. Next meeting December 12. A paper on the Development of Transportation will be presented by Col. F. G. Jonah, assistant to president and chief engineer, St. Louis-San Francisco.

SOUTHEASTERN CARMEN'S INTERCHANGE ASSOCIATION.—J. E. Rubley, Southern railway shops, Atlanta, Ga.

TRAVELING ENGINEER'S ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

WESTERN RAILWAY CLUB.—Bruce V. Crandall, 189 West Madison St., Chicago. Meetings third Monday in each month, except June, July and August.

SUPPLY TRADE NOTES

The New York City office of the Joyce-Cridland Company is now at 105 West Fortieth street. Arthur S. Beattys is eastern sales manager.

The National Malleable & Steel Castings Company, Cleveland, Ohio, is constructing an annealing plant, 100 ft. by 500 ft., in Indianapolis, Ind.

The Economy Electric Devices Company, Chicago, has been appointed central western sales representative of the Chausse Oil Burner Company.

W. G. Cook has been appointed manager of packing sales, Chicago branch of the United States Rubber Company, with headquarters at Chicago.

J. D. Purdy, who has been chief draftsman of the Pilliod Company for many years at Swanton, Ohio, has been appointed mechanical engineer, with office at the same location.

The Sullivan Machinery Company, Chicago, has established a branch office and warehouse in Los Angeles, Cal., at 442 East Third street. Benjamin P. Lane is the local manager.

E. T. Wade has been appointed representative in the southern territory for the Franklin Railway Oil Company, Franklin, Pa. Mr. Wade's headquarters are at 1125 Mutual building, Richmond, Va.

Frederick E. Bausch, 1105 Chemical building, St. Louis, Mo., has been appointed district representative in eastern Missouri and southern Illinois, of the Conveyors Corporation of America, Chicago.

T. B. H. Askin has been appointed sales manager for the intermountain division of the American Manganese Steel Company, Inc. Mr. Askin's headquarters are at Denver, Colo.

The Premier Staybolt Company, Pittsburgh, Pa., has opened a Chicago office in the Peoples Trust & Bank building, 30 North Michigan boulevard. L. W. Widmeier, assistant to the president, is in charge of this office.

H. V. Beronius has been appointed representative in Iowa, Kansas, Nebraska, Oklahoma and Northwestern Missouri, with headquarters at 33 Linwood Terrace, Kansas City, Mo., for the Gibb Welding Machine Company, Bay City, Mich.

The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, in following out a program of improvement in the production of hollow staybolt iron, has installed a new automatic mill which eliminates considerable manual labor and controls the evolution of the bar automatically.

W. R. Hans, who has been in the service of the Whiting Corporation, Harvey, Ill., for a number of years, has been placed in charge of a new district sales office opened by that company at 997 Ellicott square building, Buffalo, N. Y., to succeed its former agent, George F. Crivel & Co., Buffalo.

G. E. Emmons, vice-president in charge of manufacturing of the General Electric Company, Schenectady, N. Y., who has been identified with the electrical industry since 1886, has been relieved of the responsibilities of his position and is planning to move from Schenectady to Pasadena, Cal.

Tom Moore, 811 Royster building, Norfolk, Va., has been appointed railroad sales agent in the southeastern district for the American Bolt Corporation, New York. He will conduct the sales activities in the railroad and industrial field. Mr. Moore was formerly general purchasing agent of the Virginian railway.

The Milburn Sales Company, distributors for the Alexander Milburn Company, manufacturers of oxy-acetylene welding and cutting apparatus and portable carbide lights, have taken over the Metropolitan New York district, with headquarters at 309 Fifth avenue. E. P. Boyer, D. Keyser and other assistants will be in charge of the new agency.

N. P. Farrar, district manager of the Philadelphia territory for the Pawling & Harnischfeger Company, Milwaukee, Wis., has been appointed assistant sales manager. H. L. Mode has been

appointed sales representative in the eastern territory, with headquarters at New York and Philadelphia, Pa. Mr. Mode was formerly in the motor department of the General Electric Company.

A. B. Cooper has been appointed sales manager in the Philadelphia district with office in the Widener building, for the Central Steel Company, Massillon, Ohio, makers of Agathon alloy steels. Mr. Cooper has been identified with the steel industry for 17 years in both operating and sales work. He was formerly with the Tacony Steel Company and the Penn Seaboard Steel Corporation in the Philadelphia territory.

R. C. Broach of Atlanta, Ga., and formerly in the general sales department at St. Louis, Mo., of the Heine Boiler Company, St. Louis, has been appointed this company's southeastern district manager with office at 709 Glenn building, Atlanta, Ga. The southeastern territory consists of eastern Tennessee, North and South Carolina, Alabama, Georgia and Florida. S. B. Alexander, Charlotte, N. C., will continue as the company's special representative in North and South Carolina.

E. A. Gregory, district sales manager of the American Brake Shoe & Foundry Company, with headquarters at Houston, Texas, died on November 1, in a hospital in New York. Mr. Gregory was born in Nashville, Tenn., on March 22, 1877. He entered railroad work in 1900 with the Nashville, Chattanooga & St. Louis and in 1903 was appointed foreman of terminals of the Louisville & Nashville, at Nashville, Tenn. He remained in that position until January, 1909, when he went with the American Brake Shoe & Foundry Company. On March 1, 1923, he was appointed district manager, with headquarters at Houston, Tex.

Charles S. Gawthrop, vice-president of the American Car & Foundry Export Company, died at his house in New York City, on October 31, after a short illness, from pneumonia. Mr. Gawthrop was born in Wilmington, Del., on November 21, 1868. After graduation from the University of Pennsylvania, in the class of 1888, he entered the employ of the Jackson & Sharp Company, railway car builders, at Wilmington. In 1901 when that company was acquired by the American Car & Foundry Company, Mr. Gawthrop became district manager of the Jackson & Sharp plant, which position he held until the formation of the American Car & Foundry Export Company in 1913. He then became a director and vice-president of the new corporation and continued in those offices until his death.

C. S. Gawthrop

The stockholders of Joseph T. Ryerson & Son, Inc., Chicago, have bought a substantial interest in the Reed-Smith Company at Nineteenth and South Canal streets, Milwaukee, Wis. The Reed-Smith Company is an independent steel warehousing company serving the industry in that section of the country. It has a large and varied line of finished steel products in stock, with facilities for quick shipment. The officers of the Reed-Smith Company of Milwaukee are now as follows: D. M. Ryerson, president; George W. Smith, vice-president and general manager; E. L. Hartig, treasurer and Carl Gallauer, secretary. Donald M. Ryerson is a vice-president of Joseph T. Ryerson & Son, Inc., with headquarters at Chicago. He is a grandson of the founder of Joseph T. Ryerson & Son, Inc., and his entire business career has been with that firm. G. W. Smith was formerly a partner of the Reed-Smith Company. E. L. Hartig is vice-president, secretary and treasurer in Chicago of Joseph T. Ryerson & Son, Inc., and Carl Gallauer was in charge of its Milwaukee office. The Milwaukee stocks and facilities of the Reed-Smith Company are to be increased, and in addition, Joseph T. Ryerson & Son, Inc., will maintain daily car service from Chicago for prompt delivery of special orders.

TRADE PUBLICATIONS

Door Operating Mechanism.—A four-page folder descriptive of the Type D door operating mechanism for hopper cars, has been issued by the Enterprise Railway Equipment Company, Chicago.

Packing for Booster Ball Joints.—The application of "V" Pilot packing to booster ball joints is described in a four-page illustrated bulletin issued by the Pilot Packing Company, Inc., Chicago.

Swaging Machines.—A 32-page booklet illustrating the modern art of swaging and swaging machines has been issued by the Torrington Company, Torrington, Conn. Dimensions and capacities of the Dayton swaging machines are also given.

Decarbonizing.—The operation and application of the Ehrhart decarbonizer, which prevents accumulation of carbon in the exhaust passages and eliminates existing carbon deposits, is described in a four-page folder issued by the Pilot Packing Company, Chicago.

Face Plate Jaws.—The Independent face plate jaw, XAP-2, designed to withstand the heavy strains of holding work on powerful machining units, is briefly described in a small six-page folder issued by the Bullard Machine Tool Company, Bridgeport, Conn.

Automatic Die-Cutting Machines.—The Keller Mechanical Engineering Corporation, Brooklyn, N. Y., has issued a four-page bulletin descriptive of its Types F, BG and E-5 automatic machines, on which milling, drilling and boring operations can be performed at one setting.

Power Reverse Gears.—The various parts entering into the construction of the Precision and Type E Ragonnet power reverse gears are listed and illustrated in Bulletins Nos. 232A and 230A, which have been published by the Franklin Railway Supply Company, Inc., New York.

Centrifugal Pumps.—Mather & Platt, Ltd., Manchester, England, has prepared a 20-page brochure descriptive of its hydraulic pressure pumps of the centrifugal or turbine type. Illustrations of typical hydraulic pressure installations in railway and other general industrial practices are shown.

Ash Conveyors.—An eight-page bulletin descriptive of the American high duty conveyor for handling ashes and cinders from large power plants, has been issued by the Conveyors Corporation of America, Chicago. The conveyor is built with a 9-in. conduit, through which the ashes pass.

Floor Operated Electric Hoists.—A 60-page catalogue descriptive of Shepard floor operated electric hoists has been issued by the Shepard Electric Crane & Hoist Company, Montour Falls, N. Y. Each type of hoist is described in the following sequence: general description, installation view, portrait view, list prices, reference drawings and dimensions.

Engineering and Mechanical Literature.—A classified guide to the literature relating to the engineering and mechanical industries published between August 1, 1923, and July 31, 1924, is being distributed by F. & E. Stoneham, Ltd., London, E. C., England. This information was specially compiled for the annual conference of the Library Association, St. Andrew's Hall, Glasgow, Scotland.

Pipe Threading Equipment.—Piping and casing specifications, motor and special die information, shipping weights, dimensions, speeds, etc., of Oster pipe threading equipment, are given in a conveniently indexed catalogue, List No. 34, issued by the Oster Manufacturing Company, Cleveland, Ohio. Plain and ratchet die stocks, light hand machines with ratchets and power machines are featured in this 56-page catalogue.

Mechanical Equipment.—A five-page reprint, descriptive of its major products as shown in the 1924-25 volume of the A. S. M. E. condensed catalogues of mechanical equipment, has been issued by the Combustion Engineering Corporation, New York. The equipment illustrated includes the Lopulco and C-E direct fired systems of burning pulverized coal, the Frederick, Green, Coxe and other types of stokers, conveyors, etc.

Upset Forgings.—The American Forge Company, Chicago, has issued a 32-page pamphlet in which is described the origin, growth

and advantages of the methods used by that company in upsetting forgings. The contents contain considerable information relative to the application of AmForge upset methods in various industries and are well illustrated. There is a brief description of the method used in manufacturing knuckle pins according to standard M. C. B. specifications.

MODELS.—Interesting circulars illustrating typical miniature models of machines and mechanical appliances, ships, bridges, water works, entire factory and industrial plants, public buildings, towns, etc., have been issued by Peter Koch, Model Building Works, Ltd., Cologne-Nippes. These reduced representations correspond in detail to the full-size originals and are built especially for demonstration purposes at fairs or exhibitions, also for experimental or technical instruction.

IRON AND STEEL FOR ELECTRICAL USES.—The history and manufacture of Armco electrical sheet steels and ingot iron is outlined in a 56-page, illustrated book issued by the American Rolling Mill Company, Middletown, Ohio. The book is divided into two sections. Part I describes the development of magnetic material and the magnetic properties and various uses of Armco electrical sheet steel grades. Part II describes the physical and electrical properties of Armco ingot iron and its uses.

FILE CHART.—A complete and ready reference to the various kinds, sizes, shapes and cuts of saw files, machinists' files, miscellaneous files and rasps and extra fine Swiss pattern files, has been prepared by the Nicholson File Company, Providence, R. I., in the form of a 54-in. by 27-in. hanger printed on heavy cloth-backed paper, with wood rollers at top and bottom. The chart is also printed on 27-in. by 12-in. cards, the surfaces of both styles being varnished to permit of washing.

STOKERS.—Catalogue E-5, illustrating and describing the Type E single retort underfeed stoker and its principal parts, has been issued by the Combustion Engineering Corporation, New York. The results of typical evaporative tests of Type E stokers are given in tabulated form, and a curve shows the efficiency of the stokers at various boiler ratings, using a good grade of bituminous coal. Representative Type E stoker installations and other products of the Combustion Engineering Corporation are also listed.

WELDING ELECTRODE.—A 12-page booklet issued by the General Electric Company, Schenectady, N. Y., and bearing the designation Y-2019, describes the new Type A General Electric welding electrode. Details are given on electrode construction and characteristics. Results of tests on welded cast iron specimens and deposited metal specimens are described, and oscillograms demonstrating arc stability are reproduced. Instructions for the use of the electrode are supplied and specifications of the standard sizes given.

MECHANICAL STOKERS.—"The Condensed Catalogue of Mechanical Stokers," conceived as an important step in putting before the industrial world the breadth of service performed by mechanical stokers and the engineering organizations behind them, has just been issued by the Stoker Manufacturers' Association, Detroit, Mich. A brief, but complete engineering description of all prominent makes of mechanical stokers is presented in the book, which is a co-operative catalogue of mechanical equipment of competitive manufacturers.

GRINDING WHEEL SELECTION.—"Factors Affecting Grinding Wheel Selection" is the title of a 24-page brochure recently issued by the Norton Company, Worcester, Mass. The booklet is divided into two parts, the first part outlining for the shop superintendent, methods engineer, foreman or workman the factors involved in selecting a grinding wheel for a certain job. The second part contains a table of grinding wheel recommendations which lists many of the common grinding operations, the grain and grade of wheels to be tried first, the usual range of wheels, etc.

AIR BRAKE EQUIPMENT FOR GASOLINE-DRIVEN RAIL CARS.—Rules intended to cover in a condensed form the important instructions to be observed in the operation of SME brake equipment, designed for use on single gasoline-driven rail cars or on trains composed of one motor car and one trailer car, and a complete description of its construction and operation, are given in a 53-page instruction pamphlet, No. 5056, issued by the Automotive Division of the Westinghouse Air Brake Company, Pittsburgh, Pa. Simple diagrammatic charts show the connections which are made between the various ports and passages of the respective devices.

PERSONAL MENTION

General

B. M. BROWN, superintendent of motive power and equipment of the Southern Pacific Louisiana lines at Algiers, La., has been promoted to chief assistant superintendent of motive power of the lines in Texas and Louisiana, with headquarters at Houston, Tex., succeeding R. U. Lipscomb.

R. U. LIPSCOMB, assistant superintendent of motive power of the Southern Pacific lines in Texas and Louisiana, has been promoted to superintendent of motive power of the new Eastern district, formed by the lease of the El Paso & Southwestern to the Southern Pacific, with headquarters at El Paso, Tex. Mr. Lipscomb was born on March 5, 1873, at Brenham, Texas. He entered railway service as a messenger boy on the Southern Pacific at San Antonio, Tex., on January 1, 1889, and later served as shop clerk, time keeper and machinist apprentice. After completing his apprenticeship he was employed as a machinist until 1905 when he was promoted to machine shop foreman at San Antonio. Mr. Lipscomb was promoted to general foreman in 1912 and held that position until 1916 when he was promoted to assistant mechanical superintendent of the El Paso division. In 1919 he was promoted to chief assistant superintendent of motive power and equipment of the Texas & Louisiana lines, with headquarters at Houston, Tex.

THOMAS PAXTON, superintendent of motive power of the El Paso & Southwestern, with headquarters at El Paso, Tex., has retired. Mr. Paxton was born on January 30, 1855, in Hampshire county, Virginia, and entered railway service in 1873 as a machinist apprentice of the Baltimore & Ohio. From September, 1879, to April, 1884, he was employed as a machinist on the Texas & Pacific; the St. Louis, Iron Mountain & Southern, now a part of the Missouri Pacific; the Pennsylvania and the Wabash. He was appointed roundhouse foreman of the Atchison, Topeka & Santa Fe in April, 1884, and held that position until April, 1889, when he was promoted to master mechanic of the Argentine terminal. Mr. Paxton was transferred to the Middle division in September, 1889, and continued in that capacity until February, 1897, when he was transferred to the Chicago division. He was promoted to general master mechanic of the Texas lines in February, 1901, and in February of the following year, was appointed superintendent of motive power of the Colorado & Southern. Mr. Paxton was appointed master mechanic of the Central division of the St. Louis-San Francisco in April, 1903. In February, 1904, he was appointed master mechanic at the Baring Cross shops of the Missouri Pacific at Little Rock, Ark., and held that position until August, 1904, when he was appointed master mechanic of the El Paso & Southwestern. He was promoted to superintendent of motive power on June 1, 1905, in which position he remained until his recent retirement.

Master Mechanics and Road Foremen

S. L. MIDER, assistant road foreman of engines of the Cincinnati division of the Pennsylvania, has retired.

J. G. SWARTZ has been promoted to assistant road foreman of engines of the Cincinnati division of the Pennsylvania.

W. G. REID has been appointed master mechanic of the Rio Grande division of the Southern Pacific, with headquarters at El Paso, Tex.

A. G. NEWELL has been appointed road foreman of engines of the Rio Grande division of the Southern Pacific, with headquarters at El Paso, Tex.

M. L. HULL has been appointed road foreman of engines of the New Mexico division of the Southern Pacific, with headquarters at Tucumcari, N. M.

JOHN B. ICSMAN has been appointed master mechanic of the Lehigh & Hudson River, with headquarters at Warwick, N. Y., succeeding R. T. Jaynes, deceased.

G. H. WARNING has been appointed master mechanic of the Saskatchewan district of the Canadian National, with headquarters at Regina, Sask., succeeding H. R. Simpson, deceased.

Eugene Gordon has been appointed master mechanic of the New Mexico division of the Southern Pacific railroad, with headquarters at Tucumcari, N. M. Mr. Gordon was born on January 19, 1864, at Point Arena, Cal. He entered the employ of the Union Pacific as a locomotive fireman in November, 1887, and was later promoted to engineman on the same road. From May, 1896, to August, 1896, he served as an engineman on the Charleston & Savannah, a subsidiary of the Plant System. From October, 1896, to July, 1901, Mr. Gordon was successively employed as engineman, road foreman and division foreman of the Mexican Central. Leaving the employ of the Mexican Central, he was appointed an engineman on the El Paso & South Western, later holding the positions of traveling engineman, division foreman and master mechanic. He remained in the latter position until his appointment as noted above.

E. Gordon

Clarence F. Parker, whose appointment as master mechanic of the Kansas City Southern with headquarters at Heavener, Okla., was announced in the November issue of the *Railway Mechanical Engineer,* was born on September 1, 1881, at Mineral Springs, Ark. Mr. Parker attended the Henderson Academy at Mena, Kans., and in 1905 he took special night courses at the Pittsburg High School and the Kansas State Teachers College. In July, 1898, he entered the employ of the Kansas City, Pittsburg & Gulf, now the Kansas City Southern, as a call boy at Mena. Later he worked as a machinist, in March, 1905, being transferred to Pittsburg, Kan., where he finished his apprenticeship as a machinist. In April, 1919, he was promoted to assistant roundhouse foreman and four months later he became night roundhouse foreman; in October, 1920, assistant roundhouse foreman, and in January, 1921, general roundhouse foreman.

C. F. Parker

Car Department

C. O. Keagy, general foreman of the Meadows shops of the Pennsylvania, has been transferred as general car foreman to Wilmington, Del., succeeding F. W. Anderson.

E. E. Arnold, general car inspector of the Southern district of the Missouri Pacific, with headquarters at Little Rock, Ark., has been appointed superintendent of the De Soto, Mo., shops.

F. W. Anderson, general car foreman of the Maryland division of the Pennsylvania, at Wilmington, Del., has been appointed general foreman of the Pittsburgh division, with headquarters at Pitcairn, Pa. The position of general foreman, Ebenezer shop, Buffalo, N. Y., has been abolished.

Shop and Enginehouse

L. J. Ballard has been appointed night roundhouse foreman of the Missouri-Kansas-Texas, with headquarters at Dallas, Tex., succeeding F. H. Brown.

J. R. Wheary has been appointed general foreman of the Norfolk & Western, with headquarters at Crewe, Va., succeeding J. W. Hendricks, transferred.

C. A. Reinhard has been appointed general foreman of the Norfolk & Western, with headquarters at Williamson, W. Va., succeeding J. R. Wheary, transferred.

F. H. Brown, night roundhouse foreman of the Missouri-Kansas-Texas, at Dallas, Tex., has been promoted to general foreman, with headquarters at Denison, Tex.

John T. Butler, assistant erecting foreman of the Delaware, Lackawanna & Western at Scranton, Pa., has been appointed erecting foreman, succeeding E. A. Koschinske.

Robert Fisher, boiler foreman of the Terre Haute division of the Chicago, Milwaukee & St. Paul, has been promoted to general boiler foreman, with headquarters at Miles City, Mont.

George Allen, machinist and machinery inspector of the Illinois Central at Jackson, Tenn., has been promoted to night roundhouse foreman, with the same headquarters.

R. W. Wilcox, who has been in the employ of the Illinois Central since 1890, has been promoted to general foreman of the shops and roundhouse at Jackson, Tenn., Mr. Wilcox started as machinist in the Paducah, Ky., shops, where he advanced steadily. About ten years ago he was appointed day roundhouse foreman at Jackson.

Purchasing and Stores

James E. Kilborn, purchasing agent of the Rutland, with headquarters at Rutland, Vt., has resigned.

R. C. Arnoll has been appointed purchasing agent of the Rutland, with headquarters at Rutland, Vt., succeeding J. E. Kilborn, resigned.

L. G. Pearson, general storekeeper of the El Paso & Southwestern, has been appointed district storekeeper of the new Eastern district of the Southern Pacific, with headquarters at El Paso, Tex.

G. T. Richards, assistant district storekeeper of the Chicago, Milwaukee & St. Paul at Dubuque, Iowa, has been promoted to district storekeeper of the Southern district, with the same headquarters, succeeding J. E. Dexter, deceased.

Obituary

Maham H. Haig, master mechanic of the Pecos division of the Atchison, Topeka & Santa Fe, with headquarters at Clovis, N. M., died from pneumonia on November 10. Mr. Haig was born on July 9, 1878, at Charleston, S. C., and was graduated from Cornell university in 1900. He entered railway service in July of that year as a machinist apprentice on the Illinois Central and later served as a machinist and foreman for the same company. In April, 1906, he resigned to become editor of the Railway Master Mechanic and in February, 1909, re-entered railway service to become betterment assistant for the Atchison, Topeka & Santa Fe, where he was engaged in the betterment work of the bonus department. Mr. Haig later entered the motive power department and on December 1, 1909, he was promoted to mechanical engineer, with headquarters at Topeka, Kans. During the latter part of 1921 he was appointed master mechanic of the Pecos division.

M. H. Haig

R. T. Jaynes, master mechanic of the Lehigh & Hudson River, died at Warwick, N. Y., on November 4. Mr. Jaynes, who was born in 1865, began his railroad career as an apprentice in the shops of the Erie at Susquehanna, Pa. He subsequently worked for various railroads, entering the employ of the Lehigh & Hudson River in 1895 as general foreman.